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NOTICES OF NEW BOOKS,
AND THE
PROCEEDINGS OF THE SOCIETY.

JOURNAL
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MARCH, 1928.

TRANSACTIONS OF THE SOCIETY.

I.—PRESIDENTIAL ADDRESS :
STAINING AND STRUCTURE.

By JAMES A. MURRAY, M.D., F.R.S.

(Read January 18, 1928.)

THE history of discovery in microscopic anatomy is closely bound up with advances in the technical manipulation of the material the subject of investigation, and it is not unprofitable to survey the course of discovery from this point of view. We may thus obtain a conception from an unusual angle of some of the factors which have been most prolific of progress. For the most part I shall omit the consideration of the development of the optical equipment and shall start from the time when achromatic objectives were already at the disposal of the microscopist. In the previous periods exceptional visual acuity and heart-breaking industry were the main essentials in the microscopist's armamentarium. With the introduction of an optical equipment whose performance approximated to that theoretically possible, anyone was able to obtain optical images reasonably free from distortion, and the main facts in the microscopic anatomy of plants and animals were soon common knowledge and agreed. Up to this time microscopic technique was of the simplest kind: fresh tissues were made transparent by teasing or pressure and examined at once in their own watery fluids. The methods then evolved rendered the greatest services and are still in use, probably to a greater extent than ever before, at the present day,

because of the enormous improvements in optical methods now at our disposal.

Four processes are now essential in the preparation of objects from living organisms for microscopic examination—fixation, hardening, staining and mounting. Their development has been parallel, and all have contributed to our present abilities to reveal the intricate detail of organic structure. Fixation, one of the most important, aims at the instantaneous arrest of all vital processes with a minimum of disturbance in the appearance and relation of the parts. Its importance was relatively late of recognition, and it is only partially separated technically from the second process—hardening. Hardening aims at conferring such a consistence on soft bodies or bodies in which soft and hard parts co-exist, that further manipulation can be carried out without distortion. Staining is the oldest of the processes to which microscopic objects were submitted, and, in its first tentative empirical origins, merely aimed at rendering translucent objects slightly more opaque so that they would stand out from the luminous optical background. Mounting, or preservation, renders the specimens relatively permanent, permitting serious study to be renewed, shown to other workers, and the opinions formed to be revised in the light of experience.

From this rapid summary it will be clear that I regard the processes of mounting or preservation as the most important for the advancement of knowledge in the field of microscopic anatomy. The techniques of fixation and hardening arose as developments of the necessity for making permanent preparations. The oldest and still one of the most important of the preservative agents is ethyl alcohol, "the water of life" of the microscopist. Its preservative action on organic matter depends on the removal of water, which is essential to all active processes of life from the highest to the lowest. We now know that the prevention of decomposition brought about by its application depends on the arrest of bacterial growth, and its action in stopping chemical changes in the tissues of higher forms is of the same kind. It required only a superficial comparison of the microscopical appearances in fresh and alcohol-preserved organisms or tissues to discover that the brusque removal of water brought about great distortion and diminution in size, particularly of the more delicate structures, i.e., those with the highest proportion of water. The attempts which were made to obviate these disadvantages led to the use of various coagulants reflecting the advances in chemical knowledge at the times of their introduction. It gradually became customary to precede the abstraction of water by alcohol, by the use of some other killing agent, usually in watery solution, and great ingenuity and much purely empirical industry were applied to the testing out of the most bizarre combinations of inorganic and organic reagents. From the mass of this accumulated experience derives our present practice, which consists either in the use of salts of the heavy metals or of certain organic acids. The reasons for the choice of one or other group were, in the first instance, mainly the facility with which one or other of the usual

staining methods could be applied. It is only in comparatively recent times that rationally devised chemical methods have been introduced for special purposes.

The action of the various fixing agents depends on the coagulation of the proteins of the cells and tissues, i.e., on an irreversible change by which colloidal suspensions are turned into fibrillar or granular aggregates. The appearances thus obtained are now recognised as without any relation to the physico-chemical structure of the organic substrate from which they are produced. The elaborate and laborious reasoning of Butschli on the foam-structure of protoplasm has little significance for us at the present time. The foam-structure seen in living cells is merely the pattern of ground substance left between spherical aggregates of different chemical or physical character, and the structure of the ground substance itself is not the subject of direct microscopic observation, but only of inference from the arrangement and number in unit space of the diffraction discs produced by the colloidal aggregates when examined by dark-ground examination. These aggregates can change their size and consistency with amazing rapidity when the conditions of examination are changed, as anyone may see for himself by examining under high-power, by dark-ground illumination, such an organism as *Paramecium*, in water under an unsealed cover-glass. As the water evaporates, the delicate opalescence of the contents of the macronucleus is maintained unaltered up to the instant of rupture of the nuclear membrane. Immediately this occurs a coarsely granular appearance flashes across the whole macronucleus and the much brighter granules pour out of the opening. The change of state brought about by fixing agents is even more drastic, and, as far as we can judge, corresponds still less to the antecedent condition. The larger aggregates which can be recognised in living cells, on the other hand, may retain their previous size, shape and relation to each other, and such structures as the nucleus, chromosomes, nucleolus and mitochondria, yolk spheres and secretion globules, can be fixed in a manner having a close and constant relation to their condition in life.

As a matter of experience the structures in living cells are not all equally easily preserved. The shape of the cells, the size and form of the nucleus, and such details as the fibrillar structure of striped muscle, are relatively robust, and fixation with any coagulant preserves them in a reasonably true state. Hence these were first made the subject of careful study, and the main facts of their morphology were rapidly established. The analysis of the finer details of cell structure was a much slower process, and required the development of a more precise and refined technique in all four phases—fixing, hardening, staining and mounting.

To increase the transparency of the relatively thick layers which could be obtained by stripping membranes or by making free hand sections, the early workers were mainly restricted to the use of glycerine and, later, glycerine-jelly. The introduction of resinous mounting media for cellular structures was developed from the methods devised for the study of insect

skeletons, and the advantages of mounting media of refractive index close to that of glass were only finally recognised and their adoption became general in the last two decades of the nineteenth century. Final mastery of the fundamentals of microscopic anatomy was achieved by the development of two further technical advances—the production of apochromatic lenses and mechanical methods of producing thin sections—microtomes.

Microtomes developed principally through the demands of the embryologists, but each advance in their construction was immediately seized upon by the students in all other branches of microscopic anatomy. There can be no question that the ability to obtain sections of the order of 5μ or less in series, not only accelerated discovery in all branches of microscopic anatomy, but had a profound effect in stimulating progress in every branch of microscopical manipulation, more particularly in methods of staining and mounting.

The staining methods of the microscopist were, in the first instance, attempts to apply the processes of the dyer to his own problems. Logwood and carmine were for many years the main stand-by in formulæ entirely empirical and in many cases irrational. This is not surprising when we reflect that even at the present day chemists are still not agreed on the exact nature of the dyeing process in vegetable fibres of pure cellulose. It is not possible to go beyond a general statement that chemical reactions of the nature of salt formation, modified by adsorption phenomena, underlie the processes. The simplest examples of salt formation are exemplified in the use of the colourless radicals obtained from coloured aniline dyes which, in coming in contact with organic matter, combine with them to reform the coloured salt. Thus the addition of a mineral acid to a watery solution of eosin leads to the separation of a brown amorphous precipitate which is soluble in xylol. The solution is colourless, and if dropped on filter paper stains it red at once—the coloured salt is reformed. The introduction of this process into microscopy is due to Michaelis, and the reasons for its abandonment are typical of one of the principal requirements of the microscopist's staining methods. It was immediately seen, when this method of counterstaining with eosin was applied to sections as the end process before mounting in balsam, that the stain was perfectly diffuse. All structures, irrespective of their nature, were stained equally, the intensity varying only with their density. In the second place, once the colour reaction had occurred, no amount of washing with xylol or similar solvent had any effect on it whatever. These two disadvantages, inflexibility and diffuseness, render this reaction useless to the microscopist. The associated physical phenomena of adsorption and solid solution, and the relative solubility of the combination of stain and substrate in various reagents, in particular alcohol and the resin solvents, have a dominating influence on the end results and utility of all histological and cytological staining methods.

The empirical formulæ for carmine and logwood stains which were

developed by the middle of last century—picro-, alum-, borax- carmines and Delafield, Böhmer, Ehrlich hæmatoxylin—owe their significance to the precise nuclear staining which they attained. Through these reactions the cellular structure of living organisms was firmly established and the broad outlines of cytology laid down. The differences in form and size of cells were shown to be based on a constant ground plan, the central feature of which was the invariable presence of a nucleus. Hence the first concern of the new science of cytology was with the intimate details of nuclear structure. The embryologist having shown that development and growth were brought about by the multiplication and modification of cells, the details of the process by which new cells were formed, and how they acquired their nuclei, had to be found out. The researches of Flemming, v. Beneden, Boveri and the Hertwigs, in the last two decades of last century, revealed an amazing and complicated process centring around the stainable substance of the nucleus.

The precision and clearness of the microscopic images obtained with the various stains was found to depend to a considerable extent on the preliminary fixation to which the tissues had been subjected. The brilliancy of carmine staining after fixation in mercuric chloride and the delicacy of hæmatoxylin pictures after chromium and osmium fixations had an enormous influence on the choice of method by the workers in the succeeding periods. Even to-day the ease with which certain staining methods succeed after one or the other fixing agent is of the greatest service in microscopic investigation, and frequently is expressed in the erroneous form that this or that fixative is the "best."

One feature of the progress of discovery of the nuclear structures is significant. It is that the essential facts were established, not by examination of living cells, but by the study of stained preparations. It was only many years later that the whole sequence of indirect nuclear division or karyokinesis was clearly seen and figured in living cells. It furnished a partial confirmation of the conclusions drawn from the fixed preparations. The cogency of the reasoning depends on the demonstration of such a succession of stages, each easily derived from its predecessor, that the mind easily makes the step from one to the other. In the course of this work the constancy of the number of the stainable units of the nucleus emerged, and the perpetuation of individual differences in the separate chromosomes initiated a line of inquiry which has expanded into the science of genetics.

With the older methods the cytoplasmic processes accompanying nuclear division could only be seen with difficulty and in specially favourable material. The earlier pioneer work of Boveri and van Beneden on the division of the egg of *Ascaris* was done on specimens mounted in glycerine, in which the achromatic figure was rendered visible by differences in refractive index. It is only necessary to compare with the early work the later figures in Boveri's *Zellenstudien* to realise the advantage afforded by the later methods.

The most important of these methods, the method of the cytologist *par*

excellence, is the iron-alum hæmatoxylin of Martin Heidenhain. Its advantages are so great and its peculiarities so striking that they must receive a detailed consideration. Heidenhain's father, Robert Heidenhain, had developed a hæmatoxylin method in which a black chrome lake was produced by treating tissues, in relatively large pieces, with potassium chromate and then, after washing thoroughly, with a watery solution of hæmatoxylin. An intense black colouration was produced which proved, on examination of thin sections, to consist in a colouration of all the cell constituents in varying shades of black or bluish-black. The staining was occasionally of great precision, but varied with the distance from the surface, and in places was so general and so intense as to obscure all details of structure. M. Heidenhain, after many experiments, evolved the iron-lake method with which his name will always be associated. In R. Heidenhain's method a chrome hæmatoxylin lake is formed. It is largely beyond the control of the worker, and is extremely resistant to decolourising agents. M. Heidenhain turned to the iron-lakes and in the double sulphate of iron and ammonium found a salt which could effect the preliminary mordanting of the tissues in a more convenient form than the ferric chloride method of Benda. When sections, after this preliminary mordanting, were placed in a watery hæmatoxylin solution, an intense black colouration of all constituents of the tissues was produced. This lake was found to be soluble in the watery iron-alum solution, and the process of decolourisation proceeded at an unequal rate in the different cell structures. The process can be watched under the microscope and interrupted at any stage by washing in tap water. After thorough removal of the decolourising solution by washing, the preparations are dehydrated and mounted in Canada balsam and are permanent. The reaction is the most intense and precise which we possess, and furnishes the finest test of the fidelity of the fixation and other manipulations to which microscopic objects have been subjected. This is in large part due to the optical qualities of the coloured compound produced, for it is one of its most valuable properties that it does not form aggregates or pellicles of refractive index different from the mounting medium—balsam—with which it is impregnated. In this respect the method is greatly superior to practically all those which depend on aniline dyes for the colouration of cell structures. The latter, with few exceptions, increase the refractive index of the structures to which they are adsorbed to such an extent that fine details are blurred in the microscopic image. Now, while it is common knowledge that abrupt differences in refractive index furnish the most crucial tests of optical systems, few reflect that their value in this respect is due to what I may call the unfairness of the task imposed on the apparatus. Minute apertures in metallic films, or minute globules of mercury, are employed as test objects, because with them the optical performance is tested to the uttermost and slight unequal deformations of the wave-front can be easily recognised. The disadvantages of presenting a morphological problem in this form have scarcely been considered by those who have made the optical science of

microscopy their prime consideration, and the microscopic anatomists have come empirically to methods which lead to preparations the antithesis of these exacting test objects. Differences of refractive index are as far as possible eliminated and an undeformed wave-front with local diminution in intensity of the transmitted rays is aimed at. How far the accepted form of the diffraction theory of microscopic image formation applies to objects of this kind, I am not competent to discuss. The greater ease of observation of detail well above the limits of resolution in these circumstances makes it at least probable that the approach to the theoretical limits of the performance of objectives should, under these conditions of homogeneous medium, be less precarious.

Some evidence in favour of these views is afforded by their application to an age-old microscopic problem, viz., the nature and form of the markings on diatoms. Most of the discussions on this subject have been based on preparations mounted so as to enhance the differences in refractive index between the diatom frustule and the medium in which it is immersed, which has varied from air to realgar. I have attempted to eliminate refractive differences and to stain the medium in which the diatoms are embedded intensely with iron hæmatoxylin. To this end cleaned diatoms (principally *Pinnularia*, *Cymbella* and *Gomphonema*, with smaller forms) have been immersed in a solution of gelatine for several days. Small drops are then spread on slides, fixed in formol vapour and strong formol, and stained with iron-alum hæmatoxylin and mounted in Euparal. Euparal was selected as mounting medium because its refractive index is very close to that of diatom *silex*, whereas Canada balsam is more refractive. The markings are seen as very dark lines and dots, and for the most part on the inner surface of the frustule. The difficulty of deciding between black dot—white dot focus does not exist under these conditions. The appearances suggest strongly that the characteristic markings are indentations on the inner surface of the frustule, filled during life by protoplasmic processes.

One of the greatest advantages of the iron hæmatoxylin method is its catholicity and its sensitiveness to slight differences in the preliminary treatment of the material. At the end of the nineteenth century, when cytologists were in the main interested in the nuclear phenomena and the associated problems of cell mechanics, it was found that the addition of acetic acid to the fixing solutions gave additional clearness to the images of the cytoplasmic radiations accompanying cell division. These asters, as they are called, are easily seen in many dividing cells, but are greatly reduced or absent in the intervening "resting" phases. Altmann and Benda were the first to demonstrate that the clarity of the cytoplasmic pictures after fixation in mixtures containing acetic acid was in part due to the disappearance of granular and filamentous structures under its action. In preparations made with the omission of acetic acid, these granules and filamentous structures were present in characteristic form and arrangement. Altmann designated them as "granules." Benda gave them the name by

which they are now universally known—mitochondria. They can be seen in many living cells, e.g., the kidney, and many complicated and laborious processes have been devised to demonstrate them. In most of these an energetic mordantage with chromic compounds is applied, and it is found, when this has been done, that they can be stained very precisely with iron hæmatoxylin. This means that they retain the stain after most of the other cell organs have been decolourised. It is practically certain that the action of the chromic salts is to combine with and render insoluble peculiar fatty substances in the surface layers of the mitochondria, and these chromated lipins acquire a strong affinity for the iron-lake. Practically all the most recent and careful work on mitochondria has been carried out on material stained in this way.

This same sensitiveness to the preliminary fixation has been utilised in another field, that of Protozoology. Fixation with mercuric chloride in alcohol of 30–60 per cent. permits an accurate decolourisation of the iron-lake, and practically all the most careful morphological work on the protozoa is now carried out on such material. This of itself is a wonderful tribute to the value of the method when we recollect that the elective staining of the different cell organs of protozoa can be attained with a one solution stain—Giemsa and other modifications of the Romanowsky formula. Here, again, it is the optical quality of the final result which is the deciding factor. The iridescent refractile quality of minute deeply-stained bodies in Giemsa preparations is objectionable. Coupled with the relatively coarsely granular character of the colouring matter, which is more of a surface deposit than a stain, the limit of resolution in the coloured preparations is sooner reached than in the pure monochrome of the iron-lake.

It would be tedious to elaborate further the fields in which the advantages of this wonderful method have gradually ousted other means of demonstrating microscopic structures, and it may be asked whether further improvements are possible, or, in other words, are there any drawbacks to the employment of this technique. The most important disadvantage from which the method suffers is the very property which recommends it to the morphologist—its want of selectivity. Structures of the most varied chemical composition can be stained by its means, frequently to the exclusion of everything else. In introducing the subject of staining, it was pointed out that the colour reactions involved were not pure chemical reactions, although chemical processes were in part responsible. Advance must come in the direction of increased reliance on specific chemical reactions, the adsorptive side of the process being subordinated to the highly important aspect of permanency. Many attempts have been made to apply the reactions of pure chemistry to the demonstration of chemical compounds *in situ* in microscopic preparations. A great number of these have been undertaken without a clear appreciation of two of the most obvious difficulties. The first is that many of the reactions on which the chemist relies for the identification of compounds or elements are profoundly modified or may fail in

the presence of even minute traces of other substances. This is particularly the case in the reactions and solubility of complicated organic compounds. In the micro-chemical problems of the biologist it is rarely possible to deal with isolated substances, or to remove interfering compounds without destroying the underlying structure. The second difficulty lies in the necessity for a reaction the end product of which shall be insoluble and either coloured or opaque to a sufficient degree to be visible under the microscope.

The first of these difficulties is well exemplified in the reactions for fats. These reactions are of two kinds. In the first, advantage is taken of the greater solubility of some dyes—Sudan, scarlet, and chlorophyll—in fats and fat solvents than in water or dilute alcohol. When a solution in dilute alcohol of one of these dyes is applied to a section containing them, the dye accumulates in the fat globules and cannot be removed by dilute alcohol. The other reaction depends on the reduction of osmic acid to the black hydrated dioxide. Only the fats which contain oleic acid give this reaction, palmitic and stearic, the saturated fatty acids, do not. The fats in animal bodies generally consist of a mixture of esters of all three fatty acids, and it not infrequently happens that the proportion of oleic ester is so small that microscopically recognisable blackening does not occur.

A beginning has been made in the task of finding colour reactions for the more complicated protein compounds with the nucleal reaction of Feulgen. With this reaction it is possible to colour specifically the thymonucleic acid of animal nuclei, showing its restriction to the chromosomes and its absence from nucleoli. In iron hæmatoxylin preparations these structures stain alike, as they do with the majority of nuclear stains. Progress along these lines is slow, but the necessity for it is urgent. It is only in this way that the full chemical significance of many cellular changes can be elucidated.

It may appear inappropriate to many in this Society, so largely representative of the amateur element, to have devoted this lecture to a subject which mainly concerns the professional biologist. To this I would reply that the distinction is largely illusory. The so-called professional microscopist must be in a very real sense an amateur if he would go far in the science. If he has not the humble enthusiasm which is sustained by the pleasure in viewing microscopic images pushed to the limit of technical perfection in every way, the path of discovery in microscopic anatomy is not for him. The same standard of scientific accuracy is accepted by both categories of microscopists, and as little as the amateur will tolerate microscopical manipulations by the professional biologist which infringe the laws of the formation of microscopic images, should he be prepared to ask indulgence for himself in the province of the manipulations which, simple or complicated, prepare objects for examination?

II.—THE DEVELOPMENT OF CHLOROPLASTS IN THE SPORES OF OSMUNDA.

By KATHLEEN S. N. KIRBY, B.Sc.

(Read November 16, 1927.)

FOUR TEXT-FIGURES AND TWO PLATES.

INTRODUCTION.

THAT the spores of *Osmunda*, unlike those of the majority of other ferns, contain chlorophyll is well known, but the structure of the plastids and their origin and development have not previously been investigated. This study involved the problem of the presence or absence of mitochondria in the cells from which the spores are descended, and a demonstration of any organic continuity which might exist between the mitochondria and the chloroplasts. Thus it was necessary to examine sporangia at all stages of development up to maturity. Material was supplied mainly by the Chelsea Physic Gardens and by Kew Gardens. The species examined were *O. palustris aurea* and *O. gracilis*, and some observations were made upon *O. regalis*.

O. palustris aurea is a native of Brazil. It is a small species with rather pale green leaves, and, unlike *O. regalis*, shows only occasionally the character of mixed sterile and fertile regions of the lower pinnae. It is green in colour, and it is difficult to account for the name *aurea*, unless possibly it refers to certain fertile axes which bear spores with relatively few chloroplasts. *O. gracilis* is an extremely large species from North America, the fronds often attaining a height of 4 ft. or 5 ft. The spores of this species are said to be incapable of germination in cultivation. *O. regalis* was obtained from plants in pots at Chelsea and from vivaria at Kew.

TECHNIQUE.

For the study of mitochondria the methods of Benda (1901), Altmann (1890), and Lewitsky (1925), were used. The last is a mixture of formalin and chromic acid, allowed to act for three days and then replaced by a mixture of chromic and osmic acids acting for a week. This treatment gave the best results for the fixation of sporangia in the younger stages, but was sometimes found to cause rupture and distortion of the spore walls. With Benda's fixative the results were less satisfactory in the younger stages.

owing to the vacuolar appearance of the cytoplasm, but the mature spores were fixed by it in a perfectly normal manner. Altmann's fluid gave satisfactory results. After washing, the material was run up by the dropping method and embedded in paraffin wax.

For non-mitochondrial preparations Carnoy's fixative was used.

Sections were cut at 10μ , and various staining schedules recommended for mitochondria were employed. The method giving the most consistently good results was that of Bensley, the sections being bleached by permanganate followed by oxalic acid, mordanted with copper acetate and stained with a weak hæmatoxylin solution. The preparations were blackened by potassium bichromate and destained by Wiegert's ferricyanide. Altmann's acid fuchsin method was also used. Some attempt was made to combine these stains

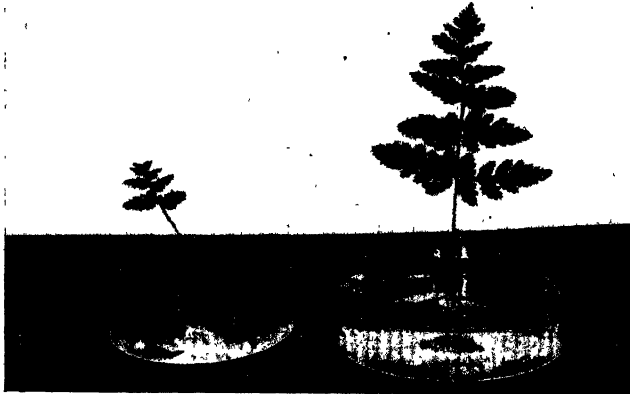


FIG. 1.—Culture Vessel.

(Photographed with frond of another fern.)

for mitochondria on the one hand with the gentian-violet-iodine method for nuclear structure on the other, with the object of distinguishing the mitochondria from the chromosomes more readily in stages of nuclear division; but it was, on the whole, not successful, in spite of one or two promising preparations in which the nuclei were stained violet, and the mitochondria, while plainly visible, were considerably under-stained. The method, if practicable, would have stained the cell walls and would have been of great advantage in counts of mitochondria in the cells. Heidenhian's iron-alum hæmatoxylin was also used, but with less success than the weaker solution and copper mordant of Bensley.

Control observations were made on living cells, and for this it was found necessary to keep fertile fronds of *Osmunda* in culture solutions in the laboratory, so that they were continually at hand for examination.

As it was found that the amount of handling of the fronds influenced considerably their duration of life under cultural conditions, vessels were devised in the use of which handling was reduced to a minimum. A short piece of glass tubing of suitable dimensions was cut and sealed vertically to a watch-glass or petri-dish by means of paraffin wax. The wax was poured round the base from a hot knife, a gap being left at one side to allow the culture solution to enter. By these means the solution could be renewed without disturbing the frond in the tube. (Fig. 1.)

A series of experimental culture solutions was tried. The basis of all the solutions was of the type used by Robbins (1922) in his work on the growth of the excised root tips of corn, and consisted of Pfeffer's solution with additions of glucose and peptone or autolysed yeast in various concentrations. Glucose was added to the extent of 2 p.c. to solutions A, C, G, and I, and 1 p.c. to solutions D, F, J, and L, autolysed yeast 0.02 p.c. (by volume) to A and D, 0.2 p.c. (by volume) to C and F, and peptone 0.04 p.c. to G and J, and 0.4 p.c. to I and L. The autolysed yeast was prepared, when required, by heating an ounce of baker's yeast in an oven at a temperature between 45–50° C. for 18–24 hours, and filtering off the autolysate.

Cultures of *O. regalis* in the yeast series all became flaccid within twelve hours, possibly owing to unsuitable osmotic concentration. The peptone series was not tried for this species. A full series of cultures of *O. gracilis* was made, and a yeast series of *O. palustris aurea* with one culture in L.

From the results it was evident that for both species the most advantageous conditions for healthy survival were the lower glucose concentrations, yeast in preference to peptone, and the higher concentration of yeast in preference to the lower. These conditions were fulfilled by solution F. These findings are similar to those of Robbins for corn root tips, with regard to peptone and yeast, but contrast with them with regard to the glucose concentration. For total survival irrespective of condition, however, the higher glucose concentration is more advantageous. That the cultures take some time to become adapted to the higher osmotic pressure, but subsequently thrive on it, is a possible explanation of this disparity. Peptone and yeast make little apparent difference in this case, and the same is true of the two yeast concentrations.

Since for the purpose of this work longevity was not the aim, but rather healthy survival for a period of a few days, solution F appeared to be the most suitable for constant use. When, however, older fronds with fully-developed photosynthesising pinnæ were available, a simple Pfeffer's solution was used, and in two cases fronds with dehiscent sporangia were kept in a healthy condition for eight weeks, at the end of which time the lower pinnæ were exfoliated and the upper pairs began to wither.

In practice it was found that little actual development of the fronds took place under cultural conditions except along certain lines. Thickening of spore walls and dehiscence of sporangia occurred in many instances, the latter even after two or three weeks of culture in Pfeffer's solution. In

O. gracilis in one case spores were formed in culture, and in another case the frond became partly uncoiled and the sporangia developed from the eight to the sixteen sporogenous celled stage.

It was found necessary to change daily all solutions containing yeast, as many yeast cells not killed by the autolysing process became active in the glucose solution.

For examining the young fresh sporangia with an immersion lens a raised platform was made on the slide, with small squares of glass stuck to its surface with Canada balsam and passing over them a length of two-ply wool previously soaked in water to remove air bubbles which might reduce its capillary power. The wool was teased apart into two strands in the centre, and the coverslip with a hanging drop containing the sporangia was laid over the wool and sealed at the corners and between the strands of wool to the glass platform by paraffin wax. One end of the wool dipped into a raised beaker of water and the other hung over a watch-glass. By this method, dependent upon capillarity and the principle of the siphon, the sporangia were kept moist and could be irrigated with ease by iodine or other reagents

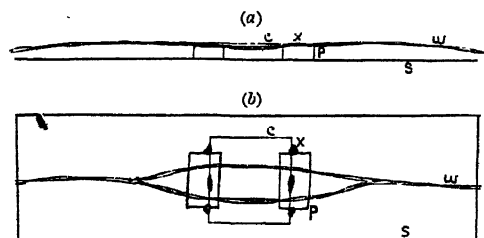


FIG. 2.—Method of Irrigation on the Slide. (a) Section. (b) Surface view.

c = coverslip. s = slide. p = platform. x = wax. w = wool.

by putting a few drops of it on the wool on the beaker side of the slide. This is a simplification of the method used by Burrows (1912) for supplying fresh solution to hanging drop cultures.

For the examination of sporogenous tissue of young sporangia, a portion of the pinnule was cut repeatedly with a knife, so that cells could be examined without the intervention of the sporangium wall. Sections were also cut with the freezing microtome, but this was not considered a strictly reliable method, the effect of freezing on the cell inclusions not being determined. In later stages, when the tapetum began to disorganise and to leave the adhering spore-mother-cells in a globular mass, it was found possible to set this mass free by bursting open the sporangium with a knife before examination. These were examined in water and in isotonic salt solutions.

The granules in living cells were visible without staining, and it was unnecessary to use Janus green, which, however, gave them a pale blue colour when used in a concentration of 1 in 30,000. They were stained brown by iodine, which was also used for the demonstration of starch grains in the chloroplasts.

OBSERVATIONS.

Osmunda palustris aurea.

In sections of young sporangia which contained from one to four sporogenous cells no granules were apparent, and, if present, were so small as to be indistinguishable from the cytoplasmic matrix. In fixed preparations of sporangia with eight sporogenous cells minute granules appeared distinctly in the cytoplasm and could be counted with some slight degree of accuracy (Plate 1, fig. 1). In sporogenous cells at whatever stage of development the nucleus was large and spherical or ovoid, frequently containing two to four nucleoli with several crystal bodies in each. The nucleus filled the bulk of the cell, except for thin layers of cytoplasm between it and the faces of the cell walls and in the angles. The granules which were scattered throughout the cytoplasm thus often occurred in groups in the angles. Similar grouping was found by Randolph (1922) in leaf tissue of normal green maize, but at a later pre-plastid stage of development. In sixteen-celled sporangia many but not all of the granules were slightly larger and more distinct, and they were easier to count with reasonable accuracy (fig. 2).

In the last-named, and in later stages, the aggregation of the granules about the surface of vacuoles was frequently noted in fixed preparations (fig. 10). The vacuoles also often contained one or more such granules in the interior. Very few living fronds of this species were available when required, and none at the later sporogenous stage preceding spore formation; but in the few cases in which such examination was possible the granules did not then appear to be especially aggregated about the vacuoles, although they occurred in the interior and exhibited Brownian movement (Lloyd and Searth (1926)). Upon *O. regalis*, which also has green spores, precisely similar observations were made at the thirty-two and sixty-four sporogenous celled stages. It is probable, therefore, that the aggregate arrangement about the vacuolar surface was due to the tensions set up in fixation, especially as it was noted more frequently in material fixed by Benda's method than by that of Lewitsky.

In the thirty-two and sixty-four celled stages (figs. 3-5) considerable variation in the size of the granules was apparent in all the cells, and it is proposed here to adopt the term "proplastid" for the larger granules, since they are definitely concerned with plastid formation and have here more nearly assumed the proportions of plastids. As used in the following pages it simply denotes the large size of the bodies referred to, and implies no other kind of differentiation. As far as terminology is concerned, there is no definite line of demarcation between "primordia" and "proplastids." The latter are strikingly similar to the bodies in maize described as proplastids by Randolph (1922).

It is in these stages also that the method of multiplication of these bodies was observed (fig. 7). In the fixed and living states proplastids were frequently seen to be surrounded by several small granules, and on closer examination of fixed preparations, fine connections were visible between some of the granules and the proplastids. Other cases in both fixed and living material were observed in which the proplastid had one or several protrusions, but the finer connections could not be traced with certainty in the living state owing to the fact that the methods adopted did not allow of sufficiently strong illumination. The inference is that small granules were budded off from the proplastids, and as they were often seen arranged in radiating lines from it, it is probable that repeated budding had occurred from the same region of the proplastid. In the thirty-two-celled stage the proplastids and granules could not be said definitely to be green, although they had a somewhat greenish appearance, probably due to reflection from the chloroplasts in the tapetum and sporangium wall cells, especially as it was exhibited frequently, but not always, by the nucleus. Again observations of living sporogenous cells at the sixty-four-celled stage, the stage at which the cells frequently separated and became spore-mother-cells, were not possible in this species owing to scarcity of material. Examination of *O. regalis*, however, yielded similar results, no definite green colour being noticeable. In the walls of the sporangia green chloroplasts were noted in a number of instances surrounded by faintly-coloured granules, and chloroplasts with protrusions were also seen.

Other cases were noted in the fixed and living conditions in which equal fission of the proplastids appeared to be in progress, and one or two observations were made on fixed material from which it was tempting to suppose that two such divisions had taken place consecutively, resulting in four bodies of medium size arranged in one plane, so that only one pair of them could be seen in optical section at once. This, however, might well be due to the fact that the bodies were necessarily closely aggregated, owing to the small space occupied by the cytoplasm in the cell, and have no special significance.

Combinations of these two methods of multiplication were also observed, a proplastid having a constriction in the middle, both portions being surrounded by small granules or rows of granules. Chains of proplastids more or less connected were seen in many cases in the fixed and living states, and similar chains of definitely green chloroplasts were frequently seen in the walls of the sporangia (figs. 11 and 12), suggesting that elongation of a rounded plastid, followed by constriction at various points, may occur. The appearance was similar to that figured by Zirkle (1926) from a fern prothallus, and which he states had not been observed in the sporophyte. Alternatively, it is possible that this condition may have arisen from that of a rod-shaped non-chlorophyllous primordium. Such bodies were also seen in the wall cells in some cases, and resembled the faintly green granular bodies except in shape.

In living cells the granules were often seen to be in rapid motion, but this

was not invariably the case, the same cells often containing moving and stationary granules. The motion resembled Brownian movement, and no definite streaming was observed. The proplastids were often seen to be in a state of more or less oscillatory movement, but to a much less extent than the granules, which was consistent with their larger size, and no degree of displacement sufficient to result in their rearrangement was observed.

In cases of nuclear division (fig. 6) observed in fixed preparations, the granular and proplastid bodies did not invade the limits of the original nuclear boundary until after the cell wall was laid down, but remained at the periphery, their positions with regard to the new cell wall apparently determining in which daughter cell they were included.

Of the spores examined in this work, two types were apparent, according to the presence of a low or high number of plastids, and they occurred in different fronds. Whether they were from the same or different plants was not determined, but they were quite distinct, with no intergrading series. In the one case the number was estimated to be from eighty to a hundred, counts being impossible owing to the close packing in the spore. In the other case actual counts ranged from fourteen to thirty. There were also present in the spores many small granules, and in some cases the larger proplastids were seen in those spores with few chloroplasts (fig. 14). In the other type bodies of intermediate size were absent. The plastids were frequently arranged in rows radiating from the nucleus to the periphery, but in other cases, especially in the spores with fewer plastids, they were peripheral, with their short axes at right angles to the wall. Campbell (1918) states for *O. Claytoniana* and *O. cinnamomea* that some prothallia bear archegonia and antheridia, and others exclusively antheridia. It would be interesting to know whether this in any way corresponds with prothallus production from those two types of spores.

The chloroplasts (fig. 8) were roughly lens shaped, and, except for the included starch grains, appeared homogeneous. The starch grains were easily demonstrated by iodine, and occurred in any region of the plastids. They were oval or fusiform in shape, and varied considerably in size sometimes even in the same plastid. In number they varied from four to, in one case, as many as eighteen per plastid, from six to nine being of commonest occurrence. In a few cases plastids were noted in spores containing the lower number, in which colourless regions were visible (fig. 13). These at first were taken for starch grains, but the addition of iodine failed to give the characteristic reaction for starch, giving them a faintly brown colour. Other microchemical tests for protein and fat gave negative results, and it seemed probable that they were vacuoles produced by the disappearance of the starch grains. This was the more probable since they occurred in a frond which had been cultured in Pfeffer's solution without carbohydrate. Other cases were observed at the same time in which the plastids had been extruded into water, the vacuoles being considerably larger, presumably owing to the intake of water (fig. 13).

Chloroplasts extruded into water frequently showed an appearance similar to that described by Zirkle (1926). A colourless ring was seen, with a faint boundary, upon which were green irregularly-shaped masses. This he interprets as a much enlarged vacuole, the substance of the chloroplast being reduced to fragments on its surface. Probably the same explanation is valid in this case. The application of alcohol vapour from a drop placed on the slide beneath the coverslip resulted in a green pool being formed around each plastid, the drops from different plastids quickly aggregating. It is thus probable that there was some kind of osmotic membrane around the plastid which was broken down by the tensions produced by the alcohol vapour.

A few observations were made on the effect of 1 p.c. osmic acid solution upon the plastids in spores before thickening of the walls had taken place. Cessation of motion of the granules left no doubt that the osmic acid had penetrated the spore walls. Little or no difference was perceptible in the shape of the chloroplasts after one hour of this treatment, but camera lucida drawings revealed a slight decrease in size (fig. 9). This was such as might have been avoided by the use of a solution of different concentration.

In fixed preparations the plastids do not stain so deeply as do the granules in the earlier stages, the same methods being employed in both cases.

Counts of granules were undertaken in this species, in the cells of sporangia at various stages of development, in the hope that they would throw some light on the origin and multiplication of these bodies and also possibly on their constancy or variability from cell to cell. In all the counts made the number of sporogenous cells or spores present in the sporangium was determined from the number of such cells appearing in median section, reference being made to the following table. This was compiled on the assumption that the

Number of Cells in Median Section (πr^2).	Number of Cells in Sporangium ($\frac{4}{3}\pi r^3$).
5	8
8	16
12	32
19	64
32	128
50	256

sporangia or, at any rate, the masses of sporogenous tissue were roughly spherical. Cases in which this was obviously untrue, although not infrequent, were easily avoided, the work being confined to those appearing circular in all sections. The table also assumes the regular development of the sporogenous tissue by successive bi-partition of all the initials at every stage.

Sporangia with median sections containing a number of cells not roughly corresponding to one of the figures in the table, were neglected, so that the regular development of the sporogenous tissue by successive bi-partition of all the initials at every stage, could be assumed with some degree of confidence. There was, however, some indication that the tapetum played some part in the formation of sporogenous tissue, and this may account for the occurrence of sporangia with numbers of cells in median section not corresponding with any figure in the table. It may be noted, in passing, that the occurrence of synangia, noted by Digby (1919) in this species, was also observed in two or three cases.

A similar method was employed by Bower (1923) in the study of developing fern sporangia.

Measurements of cell diameters were made by means of a micrometer 12 ocular used with a 1/12 inch objective, the centre of the nucleus being taken as the centre of the cell, since the nuclei were so large as practically to fill the cells in most cases. Thus no appreciable error was introduced by assuming the average distance between the centres of the nuclei of adjacent cells to be the same as the average cell diameter. This was a convenient method of determining the average diameter of irregular, non-spherical cells. The averages for sporangia at different stages, from eight to sixty-four celled, were found to be the same, viz. approximately 14 divisions of the micrometer ocular used as described above. This was found, by a rough method of estimation, to be an average cell diameter of about 14μ . Thus, in all counts in cells at these stages, sections which had been cut at the same thickness were comparable. The actual thickness used was 10μ .

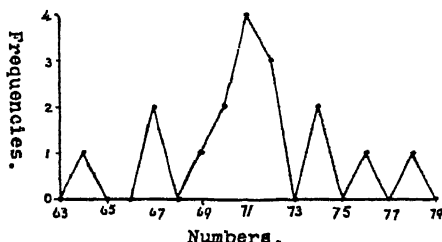
Counts of granules in eight sporogenous celled sporangia showed considerable diversity of results, ranging from 32 to 86, on the whole the numbers in the upper portion of the range predominating. At the sixteen-celled stage the range for about the same number of counts is from 88 to 108, showing an even distribution about a mean in the upper nineties. This shows a decided increase, since, if no such increase took place, the number occurring at the later stage would be half that at the earlier, and one would expect to find, say, from 16 to 43. As to the method of increase, it is possible that division of the granules takes place, which certainly occurs later on, although this could not be determined at this stage on account of their small size. But owing to their steady increase in size in the earlier stages (figs. 1-5), and the fact that it became a progressively easier task to count them, it seems possible that as the sporangium develops, granules which are below the limit of visibility increase in size, passing the limit of visibility and gradually becoming more readily counted.

In work on the thirty-two and sixty-four-celled sporangia all counts were done at least twice with each eye, once each beginning at different angles of the cell. No constant difference was discernible between the two eyes. The average of these figures was used in the later tables and calculations. The divergence between them was not usually great, but when considerable,

further counts were made until the numbers showed some uniformity. The differences are probably due to the difficulty experienced in distinguishing the cell walls, to the close grouping of the granules, and to fluctuations of attention, but are not so great in range for a given cell as for different cells at the same stage.

The following is a graph of the distribution of frequencies of counts of granules in seventeen cells at the thirty-two-celled sporangial stage, nearly all the cells being from different sporangia.

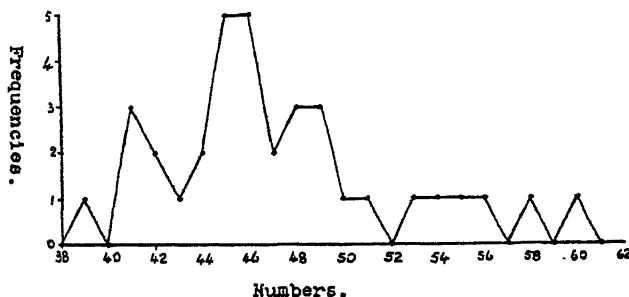
FIG. 3.
Frequencies of Numbers of Granules
in Cell Sections.
(32 Cell-stage)



This curve has its highest peak, arithmetic mean and median all at seventy-one. It has a slight skewness giving a value of 0.5 and a kurtosis of 0.21, i.e. it is definitely peaked.

The following is a similar graph for the sixty-four-celled stage, but is based upon counts of thirty-five cells.

FIG. 4.
Frequencies of Numbers of Granules
in Cell Sections.
(64 Cell-stage)



This curve has its highest peak at 45.5, its arithmetic mean at 47.26, and its median at 46.2. The measure of skewness has a value of -1.97 and of kurtosis of 0.188 . These values were calculated from the formulæ given by Kelley (1928).

Since the counts at the thirty-two-celled stage were so few, no inferences can be drawn as to the tendency toward a fixed number of granules per cell.

At the later stage the curve is open to criticism on account of its skewness, which is probably due to the fact that the sections cut included not whole cells, but on an average $10/14$ of their diameter at right angles to the plane of section. Since only cell sections containing practically the whole of the nucleus were used for counts, it was in all cases the middle region of the cell which was considered. If for the sake of simplification the cell be assumed to be spherical, with the granules evenly distributed at its periphery, it becomes apparent that sections of cells which have volumes slightly greater than the group average volume will appear to lose a small number of granules by the methods employed. On the other hand, sections of cells having slightly smaller volumes will appear to gain a number of granules proportionately greater than in the converse case. This can be expressed in terms of surface area.

Let

$$\begin{aligned} & \frac{4}{3}\pi r^3 \\ & \frac{4}{3}\pi r^3 + \frac{4}{3}\pi y^3 \\ & \frac{4}{3}\pi r^3 + 2 \cdot \frac{4}{3}\pi y^3. \end{aligned}$$

represent the volumes of spheres in arithmetical series and with corresponding radii

$$r, r + y, r + 2y.$$

If h is the height of the belt of the sphere considered (i.e. the thickness of the sections), the surface areas of the belts cut off by the sections will be given by

$$2\pi rh, 2\pi(r + y)h, 2\pi(r + 2y)h,$$

and the fractions of the total surface areas contained in the bands will be

$$\begin{aligned} \frac{2\pi rh}{4\pi r^2} &= \frac{h}{2r} \\ \frac{2\pi(r + y)h}{4\pi(r + y)^2} &= \frac{h}{2(r + y)} \\ \frac{2\pi(r + 2y)h}{4\pi(r + 2y)^2} &= \frac{h}{2(r + 2y)}. \end{aligned}$$

Since these are not in arithmetic series (but in harmonic series), the greatest difference being between the first two, it follows that fluctuations of equal magnitude on either side of a mean volume will give fluctuations of unequal magnitude on either side of a mean surface area of the parts of the cells in

section. The divergence from the mean will be greater in cells with volumes less than the mean volume than for cells with volumes greater than the mean volume by the same amount. Thus, assuming that the cell volumes fluctuate about a mean, it is probable that there is an abnormal ascendency of higher numbers of granules over the lower numbers. Thus the skewness of the curve is accounted for by the technique.

The value of the kurtosis given by Kelley for a normal distribution is 0.26815, and a definitely leptokurtic (i.e. higher peaked) distribution will have a value lower than this. Thus the distribution of the counts at the sixty-four-celled stage shows a decided peak. The probable error of the measure of kurtosis for a population of 35 is ± 0.08171 . The difference between the kurtosis of a normal distribution (0.26815) and the value found in this case (0.18292) is 0.08022, i.e. more than double but less than treble (Fisher (1925)) the probable error of each, and may have some significance, suggesting the possibility of a certain fixed number of granules per cell. If such is not the case, the inaccuracies of the method will presumably have no central tendency which would result in a peak being produced. If, conversely, there is a fixed number, inaccuracies will tend, not to increase the peak, but rather to smooth it out. To make this clear, consider a polygon containing, say, fifty dots. Perfectly accurate counts would result in a point graph with an infinite frequency at a numerical value of fifty. Very inaccurate counts, however, would give most values as fifty, a few below and a few above, resulting in a leptokurtic distribution, with a less extreme peak at fifty. Thus the peaked tendency of the curve in question is not likely to have been produced by inaccuracy and becomes the more significant.

The question then arises as to whether the peak is sufficiently great to warrant the assumption of a fixed number of granules per cell. Considering more especially the comparatively small numbers of counts made, no definite conclusion can be reached on this point, but there is at least some indication of the possibility that this is the case. Similar work on a much larger scale, and with complete cells, should determine this point.

By comparing the average for cells at the sixteen, thirty-two, and sixty-four stages, the figures being, say, between 95 and 100 in the first case and 71 and 46 respectively in the other two, it becomes apparent that, while the number per cell is decreasing, multiplication of the granules is taking place. Supposing the number present to be halved at cell division, one would expect to find these figures in geometric series, which is obviously not the case, an arithmetic series being rather approached. Some observations were made on dividing cells, beginning in sporangia at the thirty-two-celled stage. Cells in metaphase and early telophase gave counts approximating closely to 71, while cells in neighbouring sporangia in which the dividing wall was in process of formation gave numbers approximating to 92, i.e. double the average number for the sixty-four-celled stage, roughly half this number being on each side of the dividing wall (Zirkle (1927)). It thus seems probable that while divisions of the granules are definitely in progress in the resting

nuclear stages, they are more frequent or become accelerated during the later phases of nuclear and cell division.

Before comparing these figures with the numbers of plastids present in the spores, it was necessary to determine at what stage of sporangial development reduction division and spore formation took place. No material showing these stages was available, but indirect evidence was obtained by counting the numbers of spores in mature sporangia. Single sporangia were transferred to a slide, ruptured with a scalpel, and counts of the spores made under a low-power objective. There were two sources of inaccuracy, viz. (1) the possibility of spores from other sporangia adhering to the outside of the wall and (2) the probability of losing some on the knife. The following is a list of such counts of spores in sporangia taken from two different fronds of this species :—

Number of Spores per Sporangium. Frond A.			Number of Spores per Sporangium. Frond B.
211	72	109	175
131	140	89	159
143	117	213	168
129	219	180	165
148	96	195	206
118	142	246	—
120	283	218	—
109	123	98	—
117	122	206	—
137	161	204	—

Since reduction division of the sixty-four-celled stage would result in 256 spores, this appears to be comparatively rare, the commonest numbers approaching 128, while many, especially in frond B, are intermediate between these two, and in a minority of cases spores appear to have been formed at a still earlier stage of sporangial development.

If reliable counts of plastids present in spores were available, it would be interesting to compare them with the numbers of granules present in the earlier stages. By the formula expressing the relative surface areas of a sphere and a belt of a sphere, it is seen that the number of granules present in whole cells is on an average $14/10$ the number present in the sections. Thus, postulating a number in the region of 99 for whole cells at the thirty-two stage, it is obvious that multiplication of bodies must have been more rapid at meiosis and spore formation than in the earlier stages, since rough

estimates of the numbers of plastids in the spores were from 80-100, with the addition of granules, or in spores on certain fronds, from 14-30 with a similar addition. In the latter case division would, of course, have been less rapid than in the former.

Frond A in the above tables contained spores with the higher numbers of plastids, so that division in these cases must have been rapid. Frond B, on the other hand, had spores with fewer plastids, and division was therefore probably less rapid. Since the numbers of spores may indicate the omission of one or more bi-partitions on the part of some of the sporogenous cells in the earlier stages, and since also spore formation may possibly have been delayed to a stage later than that at which it most usually occurs, there may be some physiological significance attached to these results, the whole frond being perhaps less vigorous. All the spores examined in frond A, however, contained the larger number of plastids, except a very few, usually two or four in a sporangium, which were empty and obviously abortive.

Osmunda gracilis.

This species differs little in the appearance of the granules, in the early sporangial stages, from *O. palustris aurea*, but later shows great variability, a feature which is exhibited in characters other than strictly cytological. Some sporangia were observed in the later pre-spore stages which were precisely similar in appearance to *O. palustris aurea*, stages of division of the granules being noted. In other cases there were few larger granules, and in still others there were recognisable, besides the granules of various sizes, certain other bodies resembling the proplastid bodies in size and shape, but staining much less deeply (fig. 15). These may have been homologous with the other granules, but in process of degeneration, or they may have been of different origin.

Counts of the granules in this species gave results of a much greater range than in *O. palustris aurea*. At the thirty-two-celled stage a few selected typical counts are 72, 54, 19. In the last case five of them were of the pale staining type.

Any one sporangium generally contained cells all of which had, roughly, similar granular contents, but those in different sporangia, sometimes even on the same pinnule, varied considerably in number and size.

Living sporangia of this species showed similar qualitative characters to those of *O. palustris aurea*, smaller motile granules and larger stationary or nearly stationary more plastid-like bodies being noted. These, again, were of faintly green or yellow-green tint, and no definitely chlorophyllous bodies were seen. No differentiation of the larger bodies, such as might correspond with the differences in their staining properties, was observed. No starch was found in the sporogenous tissue.

Preparations of very young spores, with unthickened walls, showed the same characteristics as the cells of the later pre-spore stages.

In this species it was possible to test the effect of Carnoy's fluid in the later sporogenous stages, the same stains being used. It was found that the granular bodies were all destroyed by it, the nucleus being well fixed and the cytoplasm appearing homogeneous throughout. This points to the conclusion that the granules are all of a mitochondrial nature, being fixed by fluids containing osmic acid, and destroyed by acetic acid and alcohol.

The general variability exhibited by the species was very conspicuous in the spore characters. The size varied considerably, from a minimum of about the same order of magnitude as the few abortive spores found in *O. palustris aurea*, i.e. having a diameter of less than half that of the normal spores, to the normal size for that species, which itself exhibited little or no variation in the size of the normal healthy spores. In the smaller spores there was usually a nucleus, although cases were frequently observed in which it was absent. This was in fronds examined on the same day as they were collected, so that there is no doubt that it was not a result of unhealthy cultural conditions. In the medium and larger spores the nucleus was always present.

Variability of the non-nuclear spore inclusions was even more striking. Spores of from small to medium size were found containing as few as two granules, with or without a nucleus, and a content of from twenty (fig. 16) to a hundred or more large and small granules with a nucleus was very common. The small bodies had the familiar light greenish tint exhibited in the earlier stages, grading from this to a more or less definite yellow in the larger bodies.

In general, the larger the spore, the more granules it contained, and those approaching the maximum size were often practically filled with them. A typical spore of this order of size would contain a very large number of small faintly green granules in rapid motion, even more of a large size and yellow colour, and some of all possible combinations of intermediate characters of size and colour.

Other typical large spores contained definitely green plastids. There were estimated to be as many as five or six hundred per spore in many cases, a few intergrading granules being present and a large number of minute granules. These were usually peripheral in arrangement and were often in rapid motion. These spores were similar in general appearance to those just described except that the yellow colour was replaced by green.

The colour of these bodies, while leaving no doubt that they contained chlorophyll, was yet not quite as deep as that exhibited by the plastids in *O. palustris aurea*, and they were of slightly but definitely smaller size. They appeared homogeneous and non-vacuolar, and were found to contain no starch, in all the spores examined, with one exception.

Examination of fixed spores was of little additional value, the same types of granule being found as in the pre-spore stages.

DISCUSSION.

In both the species of *Osmunda* examined there are present in the young sporogenous cells minute granules gradually increasing in size and, in the later pre-spore stages, multiplying by division. In *Osmunda palustris aurea* these develop into green photosynthesising plastids, whereas in *O. gracilis* there is a slackening of development before the mature plastid stage is reached, the spores containing granules at all the earlier stages, and at the end of the series, granules often smaller than normal plastids and of a yellow colour. Only in some few cases are green plastids present in the spores.

This state of affairs in the spores of *Osmunda* is strikingly similar to that described by Randolph (1922) in two strains of maize, the normal green strain and certain plants of the Mendelian white strain. Not only is the early development of the granules similar, but the differences exhibited are closely parallel to the differences observed in maize, even to minor points such as yellowish colour, smaller size, and multiplicity of the granules in the final stage of the second case. He finds also, at the tip of the seedling leaf of the albino maize, a region containing green plastids corresponding to the few green spores of *O. gracilis*. Both the albino maize and *O. gracilis* spores seem to show a state of retarded plastid development. There may be even a further parallelism in the fact that the albino maize plants do not live beyond the seedling stage, and the spores of *O. gracilis* are reported to fail to germinate. The plants of *O. gracilis*, however, look normally green, and the parallelism is strictly between the spores of the two species of *Osmunda* and the plants of the maize strains.

As regards quantitative characteristics, the difference between the two species is interesting. On the one hand there is certainly some mathematical plan underlying the distribution of granules in the cells of *O. palustris aurea*, whether or not a fixed number per cell is present at a particular stage. On the other hand, *O. gracilis* is characterised by the apparent absence of any such plan.

Such a state of affairs demands some explanation. It is a further example of variation in meristic phenomena, and the words used by Bateson (1916) in discussing the striping of the zebra, and comparing it with a mackerel sky and sand ripples, are here peculiarly applicable:

"We cannot tell what in the zebra corresponds to the wind or the flow of the current."

It is comparatively easy to imagine an undefined force to be responsible for the occurrence of plan in the granules of *O. palustris aurea*, and its absence to be responsible for the absence of plan in those of *O. gracilis*, but it is less easy to define the force.

Were the presence of a constant number of granules at any stage an established fact, it might be considered an excuse for assigning to them a rôle in heredity, but, even so, there would be other possible explanations. The possibility of plastid inheritance as a factor resulting in regularity of

numerical distribution is not excluded, and, as pointed out by Andersson (1923), it might well be entirely independent of the nucleus and the distinction between haploid and diploid nuclear and somatic generations.

That the presence or absence of mathematical plan in the distribution of the granules is a matter of nuclear control, is a second possibility, and presupposes the presence in the chromosomal equipment of *O. palustris aurea* of some factor which is absent in that of *O. gracilis*. Such an explanation, while being quite self-consistent, leaves out of account the other aberrant features of the spores of *O. gracilis*, such as irregularity of occurrence of the nucleus itself and irregularity of spore size.

The third possibility, that of physiological control resulting in mathematical order in the granules of *O. palustris aurea* and its absence in *O. gracilis*, is attractive because the other observed irregularities of spore character, previously described as extreme variations, can also be ascribed to it. The evident aberrance of the species might well be a phenomenon dependent upon, or at any rate correlated with, physiological disturbance characteristic of the species.

The work that has so far been done on ferns has been confined to the higher members of the group, and differences exhibited by *Osmunda* would be expected to correlate with the differences in spore content, i.e. the presence of plastids. Emberger (1920, 1-2-3) has worked out the course of events regarding plastids and mitochondria in the sporangia of polypodiaceous ferns, which produce non-green spores. He finds that while a certain section of the chondriome remains as such throughout these stages, plastids are also present in the young sporangia, and these later become transformed into mitochondria similar to the other class in the spores, and again give rise to plastids on germination. If this sequence of events were moved backward in time relatively to the development of the sporogenous tissue, a condition similar to that in *Osmunda* would result, the plastids appearing, not as in the higher ferns at germination, but at spore formation. There is, however, a difference in that the plastid primordia in *Osmunda* do not visibly come from previous plastids in the sporogenous tissue, but appear to be entirely absent in the early stages.

Again, the chondriome in *Osmunda* differs from that in the polypods in being composed of granular instead of filamentous bodies, and in the early stages those which will develop into plastids are indistinguishable from those which remain of a chondriosomal nature up to the mature spore stage, and co-exist with the plastids.

Definitions.

As used in this paper, the term "mitochondria" includes such cell organs as are preserved by fixatives containing osmic acid and chromic acid, and destroyed by those containing alcohol and acetic acid. In the use of the word, no assumption is made either with regard to their ultimate chemical

constitution or even their relation to similar bodies in animal cells. The term "chondriosome" also merely signifies the granular form of the bodies to which reference is made, and which are of a mitochondrial nature. The "chondriome" is, of course, the total mitochondrial content.

The word "proplastid" is reserved for those bodies which are obviously in course of development into plastids, and "primordium" will be used to denote the earlier stages of such bodies when they are indistinguishable from the rest of the chondriome.

The word "plastid" is, of course, only applied to bodies observed to be definitely green in the living state, and any or all of these bodies, excepting only the plastids, have been termed "granules" indiscriminately.

Origin and Individuality of Granules and Plastids.

Since in the early stages the plastid primordia in the sporangia of *Osmunda* are indistinguishable from the rest of the chondriome, the question of origins resolves itself into a consideration of the origin of the chondriome as a whole in the young sporogenous tissue. The absence of visible granules in the very young stages admits of two possible explanations. Either they arise *de novo* in the cytoplasm of cells in the four to eight-celled sporangia, or they are present, but of such small size as to be below the limit of visibility. As already mentioned, an examination of still earlier stages would throw some light on the matter, but the present observations can only be said to yield negative evidence of their existence in these stages. In the words of Sharp (1926), "On the whole, it seems that the question of ultimate origin depends on the unknown behaviour of invisible bodies," even if their existence throughout were established.

In any case, the definite *sui generis* nature of the chondriome could not be established until its persistence, not only in the young sporangia, but throughout the complete life-cycle, had been proved.

With regard to the plastids, it is clear that *Osmunda* provides one more case in which their origin from mitochondria is demonstrated, but since their primordia constitute an indistinguishable part of the chondriome, the question of their individuality is inseparable, at this stage, from the broader question of the individuality of the total chondriome.

There are three possible views concerning the origin of chromatophores held by earlier workers and discussed at length and summarised by Cavers (1914), viz. (1) that they arise *de novo* at some point in the life cycle; (2) that they arise from pre-existing chromatophores and are permanent cell organs; and (3) that they arise from chondriosomes which are homologous with those of animal cells. Considering *Osmunda* with reference to these views, no evidence is provided which could be said to favour either (1) or (2). With regard to (3), the view upheld by Lewitsky (1910, 1925), Guilliermond (1925, 2), Emberger (1922), Twiss (1919), Alvarado (1923), Wagner (1927) and others, and contested on various grounds by Mottier (1918), Kiyohara (1926) and others, evidence

from *Osmunda* points to the conclusion that, as stated above, the chloroplasts are derived from chondriosomes as already defined. The method of plastid production differs somewhat, however, from that described by Lewitsky (1910), Wagner (1927) and others, for higher plants, and by Alvarado (1928) for *Mnium*, in which two plastids are commonly formed from one rod-shaped primordium by the production of swellings at the ends and their subsequent pulling apart. In *Osmunda* the plastids are formed from granules either by complex divisions or, it may be, singly. This corresponds more closely to the events described by Randolph (1922) in maize, but he was unable to state definitely that the primordia were of chondriosomal nature.

Kiyohara (1926) finds in *Hydrilla verticillata* that the plastids themselves are preserved by non-mitochondrial fluids, but that when mitochondrial fluids are employed, bodies are found which resemble the descriptions of mitochondria given by other writers, but which he explains as distorted plastids, presumably because no plastids normal in appearance were found in material so fixed. Such a state of affairs in which observations similar to those of other workers, were made, but are explained differently, is possibly the result of treatment of insufficient material with each of the fixatives. In any case, control observations on the living organism would help to decide this point.

The view of the origin of chromatophores from chondriosomes as put forward by Lewitsky (1910) and summarised by Cavers (1914) homologises the primordia with the similar bodies characteristic of animals. The variation exhibited by the bodies in both classes of organisms is responsible for the diversity of opinion and confusion of terminology in this connection. The work of N.H. Cowdry (1917), performed with a high degree of scientific precaution and accuracy, has put the subject on a systematic basis. He experimented on plant and animal cells under precisely similar conditions and found that variations in the one class, while great, were yet paralleled by similar variations of as great a range in the other. This fact, together with their remarkable similarity in reaction to fixatives and stains and in chemical composition as far as it is known, led him to conclude that they were homologous. Thus, while the work on *Osmunda* shows that plastids are produced from mitochondria as defined on a basis of reaction to fixatives, it is probable that these are homologous with those of animals, and that evidence from *Osmunda* supports the view of Lewitsky and others, as set forth by Cavers, that chromatophores are produced from mitochondria which are homologous with those of animals.

Current Theories Concerning Types of Mitochondria.

The theory put forward by Guilliermond (1925, 2), and based in part on the work of Emberger (1920, 1-2), on ferns, must be considered together with the views of Mottier (1918 and 1921) in the light of certain facts gleaned from the study of *Osmunda*. The relevant part of the theory is that concerned

with the existence of two functional and developmental types of mitochondria claimed to be visibly distinct, but both conforming to the definition of mitochondria based on technique.

The theory of the significance of mitochondria, as put forward by Mottier, seems to differ from Guilliermond's view mainly in matters of definition and of emphasis. Mottier's application of the term implies only the developmental distinction between plastid primordia and the other granules, while that of Guilliermond homologises them on the grounds of technique. The reason for this difference in terminology is found in the emphasis placed by Mottier (1918) on observed differences. He himself does not state specifically to what he attributes the differences in staining properties. He merely states,

"The primordia of leucoplasts are not the same as these other objects,"

and in the discussion at the end of his later paper (1921) he admits that it may be purely a matter of development. Also, in describing the meristematic cells of the root of *Pisum*, Mottier (1921) expressly states :

"In addition to the large rods are numerous very small globular or granular bodies and very slender delicate rods that stain the same colour and seem to be of the same ultimate composition as the large rods."

On the other hand, Guilliermond (1925, 2) finds it a philosophical necessity to suppose some slight constitutional difference. He says :

"Elles semblent donc constituées par la même substance, mais il est bien évident qu'elles diffèrent par la présence dans l'une d'un constituant qui n'existe pas dans l'autre, sans quoi on n'expliquerait pas leurs fonctions différentes, mais cette différence probablement très légère échappe à l'analyse cytologique."

Thus, with the emphasis removed, there appears to be no fundamental difference between the views of Guilliermond and Mottier.

The work of Emberger (1920, 3), Mottier (1918), and others, on *Selaginella* and certain bryophytes in which the chloroplasts at all stages are visibly distinct, can be explained as a stabilised difference of the same nature as the developmental differences occurring in other plants, some even in the same classificatory groups (Alvarado (1928)).

Very recently a third view has been put forward by Wagner (1927), claiming that in higher plants, not one or two, but several developmental types of granule occur side by side. He bases the theory in part on observations on *Veratrum album* L., in which some of the chondriosomes give rise to plastids in the spore-mother-cells and others break up, giving smaller

granules in the pollen grains, and these give rise to plastids at a later stage. There are thus two generations of plastids present. He considers, therefore, that in higher plants there are not two developmental types of granule according as they do or do not develop into plastids, but that non-synchronising periods of plastid production are dependent upon the presence of more than one developmental type of granule. He thus supposes that there are mitochondria of several types in higher plants, one type being those which do not develop into plastids, and the others being represented by observed developmental differences. He claims that this is an extension of Guilliermond's theory.

If two or more types of granule exist in *Osmunda*, they are certainly not morphologically distinct in the early stages of development of the sporogenous tissue. It is thus to the later stages that our attention must be turned in quest of evidence on this point.

The spores of *O. gracilis* contain an intergrading series of granules comparable to the series of stages of plastid development followed by the granules and synchronising with the development of the sporangium itself. This is similar to the state of affairs recorded by Randolph (1922) in maize, and admits of two possible explanations. Either, as Randolph apparently assumes, the granules are all of one type, any or all of them being inherently capable of development into plastids, the differences observed being purely differences of equal value in a developmental scale, or the total granular content is composed of two kinds, one of which exhibits such a developmental series in the maturation of the sporangium and in the spores themselves, even to particular spores, while the other kind does not develop beyond a certain early stage, corresponding to the size of all the granules in the sixteen-celled stage, and the two kinds occur together, the latter kind being indistinguishable from the smaller members of the former kind.

Turning to *O. palustris aurea* for further data, there is evidence on this point in the differences between the two types of spores encountered. As noted earlier, the one type contains relatively few plastids and granules of all sizes, while the other contains a larger number of plastids and many small granules, but more of intermediate size. If the difference between the spores is physiological, the possibility of which was pointed out earlier, those containing the larger number of plastids being the more vigorous, the fact that only plastids and small granules were present becomes significant. That all those bodies capable of becoming plastids had developed into maturity, and that those not destined to play any rôle in plastid formation had not developed in size beyond a certain early stage, is a possible explanation which would be in agreement with the theory of Guilliermond.

There is, however, another explanation which is consistent with the assumption of Randolph and with the facts observed in *Osmunda*. Since there is no obvious difference between the granules which develop into plastids and those which do not, it is reasonable to suppose that there may be in reality no structural difference. If this is the case, a cause for the

observed developmental differences must be sought. This may be found in the mathematical plan discussed previously. If some controlling factor is present, resulting in numerical order, this alone may account for the fact that some of the granules complete their development, while others are arrested at a certain point. Thus the number developing in the later sporangial stages would be such as would produce, in accordance with the plan, the number of plastids peculiar to the spores. The plan itself would, of course, express the facts of multiplication of the granules in the cells, and of division of the number per cell, by the process of cell multiplication.

The question then arises as to what factor conditions which of the granules shall be those to go on developing. One possible factor is plastid inheritance, and the adoption of this is the logical outcome of the theories of Guilliermond and Wagner, of which the former is not inconsistent with the evidence from *Osmunda*, but can be dispensed with if the view of a controlling factor resulting in numerical order is adopted as simpler and capable of explaining all the facts.

A second possible factor is found in the positions of the granules with respect to the nucleus, and this would agree with the proposition of a nuclear factor resulting in numerical plan in the distribution of the granules.

A third possible factor is found in the positions of the granules in the cell, relative one to another, and here the functions of the two classes of bodies must come under consideration. According to recent work by E. V. Cowdry (1926), W. H. and M. R. Lewis (1915) and others, the function of mitochondria is concerned with intra-cellular metabolism. They are found to be special regions of the cell, into and from which passage of material takes place, and they are considered to be associated with respiration. The chloroplasts, on the other hand, have a synthetic function, and act as organisers of simple chemical substances, which are taken into them and transformed into more complex substances. It is not unreasonable to suppose that individual members of both of these classes may be of maximum efficiency by serving a definite volume of cytoplasm. Thus space relationship in the cell with reference to each other might well be the selective factor in the observed developmental differences.

This again is in harmony with the possible assumption, discussed previously, of the factor resulting in mathematical order as being of a physiological nature, and is the more attractive since it suggests even more strongly a possible relation between cell size and number of plastids and granules present, or even a possible common controlling factor.

This theory obviates the necessity for assuming the existence of unobserved structural differences and eliminates the conception of more than one type of granule, explaining the observed differences of development on the basis of a factor controlling development, such a factor being of a physiological nature and being found possibly in relative positions of the granules in the cell. In this connection it is interesting to consider the work of Thurlow (1917), who found by counts of mitochondria in fields of equal area in nerve

cells of the medulla of the white mouse, that the number per unit volume of cytoplasm could be used as a pathological index. The situation appears to be analogous in some respects to the behaviour of the nuclei in such multi-nucleate cells as the developing oogonia of species of *Peronospora* and *Albugo*, also probably of *Vaucheria*. The nuclei are at first equally spaced in the cell, but as development proceeds, the peripheral ones degenerate until ultimately only the growing central nucleus, which is most favourably placed, survives. These instances again are in agreement with the supposition of a disturbance or lack of physiological equilibrium in *O. gracilis* and with that of physiological vigour in *O. palustris aurea*, expressing itself in such characters as spore size and numbers of plastids and mitochondria.

Such a theory is entirely consistent with the facts as observed in *Osmunda*. In the cases of other plants worked out by Mottier, in which slight staining differences were apparent, they, too, may be explained on a similar principle, even supposing they were admittedly structural and not physiological. If the activities of the cells were such that throughout their existence and multiplication and their specialisation, both types of inclusion were functionally necessary, it is reasonable to suppose that, on some such co-ordinating principle, both, or the rudiments of both, would be present. This again is applicable to cases of bryophyta and to *Selaginella*, as worked out by Emberger, in which plastids and mitochondria are present side by side throughout the life-cycle, and it is even possible that such is the case, not merely in these plants, but in algæ and in any other organisms in which mitochondria and other cell inclusions of physiological function are present side by side with each other or at different stages of the life-cycle.

While the work done in Europe on mitochondria has been chiefly from the morphological and structural standpoint, and has resulted largely in philosophical speculation, that in America has been from a chemical and functional point of view, and has resulted in physiological theorisation. These two schools of thought seem at first sight to be not opposed but unrelated, but further consideration shows that whatever may be the truth with regard to the rôle and ultimate nature of mitochondria, neither is complete without the other, and the two are complementary.

SUMMARY.

1. The technique employed is described, with special reference to the methods used in culture of fronds, and in observations of living sporangia.
2. Qualitative study of the sporogenous cells of *O. palustris aurea* shows a series of stages, from the absence of granules, through stages in which they appear as minute faintly green bodies, to the final spore stage, with a content of granules and plastids. Multiplication occurs in the later pre-spore stages by various types of division.
3. The mature plastids in the spores appeared homogeneous and contained starch grains embedded apparently at any point.

4. Counts of granules in sections of cells of *O. palustris aurea* revealed a mathematical plan underlying their distribution.

5. *O. gracilis* differed from this species in the apparent absence of any such mathematical plan and in the rarity of the occurrence of mature plastids in the spores.

6. The granules in the sporogenous cells of *O. gracilis* were shown to conform to a definition of mitochondria based on reaction to fixatives.

7. The apparent absence of granules in the earliest sporogenous stages is not regarded as evidence for their origin *de novo*, since they may have been present but below the size limit of visibility. There is no evidence for or against their *sui generis* nature.

8. Evidence from the spore inclusions of *O. palustris aurea* is in agreement with the theory of two functional and developmental types of mitochondria, but the facts can be explained more simply on the view that there is only one type of granule, the developmental differences being explained on a numerical basis, depending on the space relationships and functions of the granules in cellular metabolism and in the general physiological equilibrium of the organism.

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REFERENCES.

- ALTMANN, R. (1890).—"Die Elementar-organismen." Leipzig.
 ALVARADO, S. (1923).—"Die Entstehung der Plastiden aus Chondriosomen in den Paraphysen von *Mnium cuspidatum*." Ber. Deut. Bot. Ges., **41**, 85.
 ANDERSSON, I. (1923).—"Genetics of Variation in a Fern." J. Genetics, **13**, 1.
 BATESON, W. (1916).—"Problems of Genetics." New Haven: Yale University Press.
 BENDA, C. (1901).—"Verh. Anat. Ges." **15**, 172.
 BOLLES-LEE, A. (1921).—"Vade Mecum." 8th Ed. London: J. & A. Churchill.
 BOWER, F. O. (1923).—"The Ferns." 1. Cambridge University Press.
 BURROWS, M. T. (1912).—"Method of Furnishing a Continuous Supply of New Medium to a Tissue Culture in vitro." Anat. Rec. **6**, 141.
 CAMPBELL, D. H. (1918).—"Mosses and Ferns." 3rd Ed. New York: Macmillan.
 CAVERS, F. (1914).—"Chondriosomes (Mitochondria) and their Significance." New Phyt. **13**, 96, 170.
 CHAMBERLAIN, C. J. (1919).—"Chondriosomes in Plants." Bot. Gaz. **67**, 270.
 ——— (1924).—"Methods in Plant Histology." 4th Ed. Chicago: Univ. Press.
 COWDREY, E. V. (1926).—"The Reactions of Mitochondria to Cellular Injury." Arch. Path. and Lab. Med. **1**, 237.
 ——— (1926).—"Surface Film Theory of the Function of Mitochondria." Am. Nat. **60**, 157.
 COWDREY, N. H. (1917).—"A Comparison of Mitochondria in Plant and Animal Cells." Biol. Bull. **33**, 695.
 DIGBY, L. (1919).—"On the Archespörial and Meiotic Mitoses of *Osmunda*." Ann. Bot. **33**, 135.
 EMBERGER, L. (1920).—"Évolution du chondriome chez les Cryptogames vasculaires." Compt. rend. des Acad. Sci. Paris, **170**, 282.
 ——— (1920).—"Évolution du chondriome dans la formation du sporange chez les Fougères." Compt. rend. Acad. des Sci. Paris, **170**, 469.
 ——— (1920).—"Étude cytologique de la Selaginelle." Compt. rend. Acad. des Sci. Paris, **171**, 263.
 ——— (1922).—"Évolution des plastids dans le règne végétale." Revue Sci. Jan. 1922, 46.
 FISHER, R. A. (1925).—"Statistical Methods for Research Workers." Edinburgh and London: Oliver & Boyd.

- GUILLIERMOND, A. (1921).—"Sur les microsomes et les formations lipoides de la cellule." *Compt. rend. Acad. des Sci. Paris*, **172**, 1876.
- (1921).—"Observations cytologiques sur le bourgeon d'*Elodea canadensis*." *Compt. rend. Acad. des Sci. Paris*, **173**, 88.
- (1921).—"Sur l'évolution du chondriome et la formation des chloroplasts dans l'*Elodea canadensis*." *Compt. rend. Sci. de Biol. Paris*, **83**, 462.
- (1921).—"Nouvelles observations sur l'origine des plastids dans les phanerogames." *Rev. gen. Bot.* **33**, 401.
- (1923).—"Les chondriosomes dans la cellule végétale: état actuel de nos connaissances sur la structure de la cellule." *Compt. rend. Assoc. Anat.* **18**, 1.
- (1925).—"Sur l'instabilités de formes et la permanence des mitochondries." *Compt. rend. Acad. des Sci. Paris*, **180**, 221.
- (1925).—"La structure de la cellule." *Mendel Memorial Volume*. Prague.
- KELLEY, T. L. (1923).—"Statistical Method." New York: Macmillan.
- KIYOHARA, K. (1926).—"Über die Chloroplastenteilung von *Hydrilla verticillata*." *1. Bot. Mag. Tokyo*, **40**, 6.
- LEWIS, W. H., and LEWIS, M. R. (1915).—"Mitochondria in Tissue Cultures." *Am. Journ. Anat.* **17**, 339.
- LEWITSKY, G. (1910).—"Über die Chondriosomen in pflanzlichen Zellen." *Ber. Gesells.* **28**, 538.
- (1925).—"Die Chondriosomen in der Gonogenese bei *Equisetum palustre* L." *Arch. f. wiss. Bot.* **1**, 801.
- LLOYD, F. E., and SCARF, G. W. (1926).—"Origin of Vacuoles." *Science* **63**, 459.
- MOTTIER, D. M. (1918).—"Chondriosomes and the Primordia of Chloroplasts and Leucoplasts." *Ann. Bot.* **32**, 90.
- (1921).—"On Certain Plastids with Special Reference to the Protein Bodies of *Zea*, *Ricinus* and *Conopholis*." *Ann. Bot.* **35**, 849.
- RANDOLPH, L. F. (1922).—"Cytology of Chlorophyll Types of Maize." *Bot. Gaz.* **73**, 337.
- ROBBINS, W. J. (1922).—"Cultivation of Excised Root Tips and Stem Tips under Sterile Conditions." *Bot. Gaz.* **73**, 376.
- (1922).—"Effect of Autolysed Yeast and Peptone on Growth of Excised Corn Root Tips in the Dark." *Bot. Gaz.* **74**, 59.
- ROBBINS, W. J., and MANEVAL, W. E. (1922).—"Further Experiments on Growth of Excised Root Tips under Sterile Conditions." *Bot. Gaz.* **73**, 274.
- SHARP, L. W. (1926).—"Introduction to Cytology." New York: McGraw-Hill Book Co.
- THURLOW, M. de G. (1917).—"Quantitative Studies on Mitochondria in Nerve Cells." *Contrib. Embryol. (Carnegie Institute)*, **6**, 35.
- TISS, W. E. (1919).—"A study of plastids and mitochondria in *Preissia* and corn." *Am. Journ. Bot.* **6**, 217.
- WAGNER, N. (1927).—"Évolution du chondriome pendant la formation des graines de pollen chez les Angiospermes." *Biologia Generalis*, **3**, 15. *Wien und Leipzig*.
- ZIRKLE, C. (1926).—"Structure of Chloroplasts in Certain Higher Plants." *Am. Journ. Bot.* **13**, 801.
- (1927).—"Growth and Development of Plastids in *Lunularia vulgaris*, *Elodea canadensis* and *Zea mays*." *Am. Journ. Bot.* **14**, 429.

EXPLANATION OF PLATES.

All figures are from camera lucida drawings with reduction of about 1/3.

For Figs. 1-12 and 14 a 1/12 inch immersion objective was used with a Zeiss 12 ocular, giving a final magnification of about 1,700.

For Figs. 13 and 15 a 1/6 objective was used with a Zeiss ocular, giving a final magnification of about 650.

PLATE I.

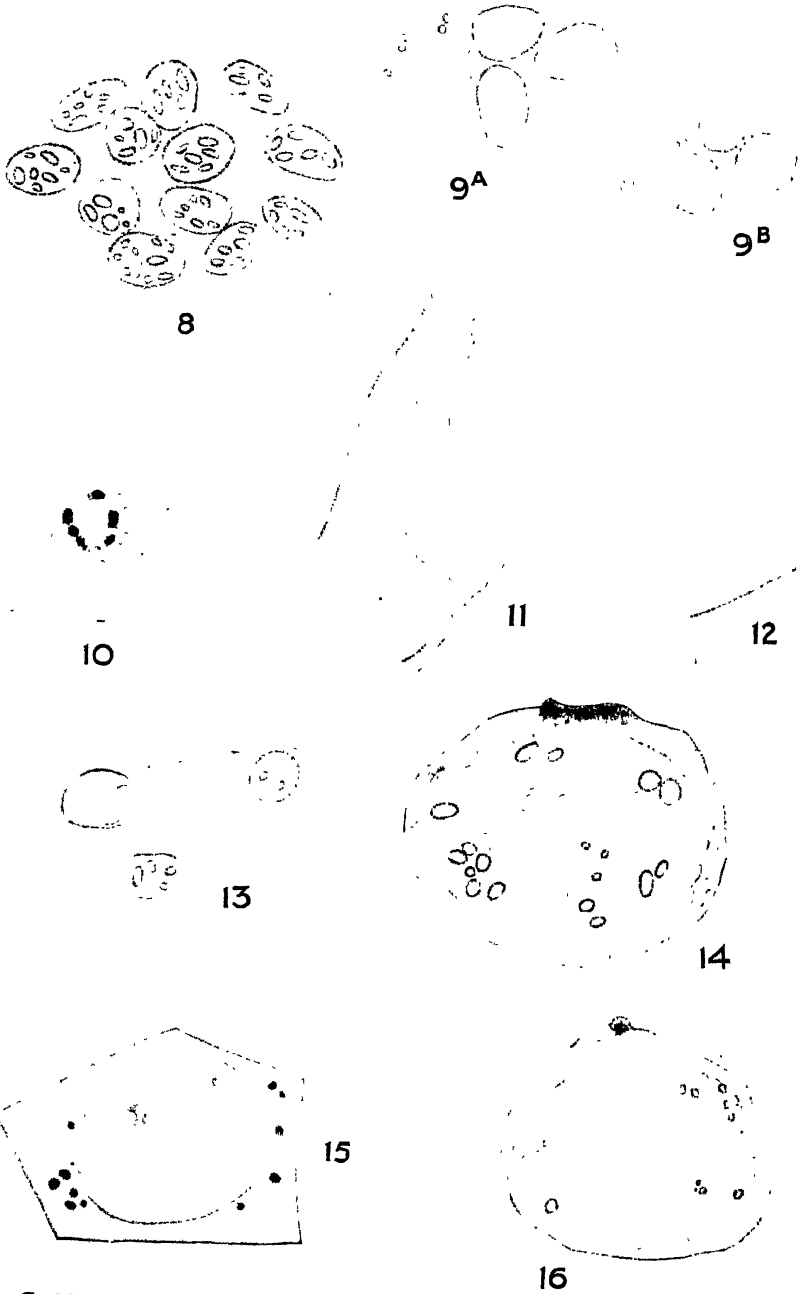
O. palustris aurea.

Figs. 1-6. Fixed cells from sporangia at different stages of development. Granules in one focal plane shaded heavily. Those in adjacent planes lighter. Those overlying the nucleus omitted.

1. From an eight-celled sporangium.
2. From a sixteen-celled sporangium.
3. From a thirty-two-celled sporangium.
4. and 5. From sixty-four-celled sporangia.
6. Dividing cell from sporangium in course of development from sixteen to thirty-two-celled stage.
7. Groups of granules, showing methods of division, from sporangia at sixty-four-celled stage. (Fixed.)



K.S.N.K. del:



K.S.N.K.del:

EXPLANATION OF PLATES.

PLATE II.

O. palustris aurea.

8. Chloroplasts from spores. Starch grains visible stained with iodine.
9. Plastids and granules from same spore (*a*) before, (*b*) after fixation with 1 p.c. osmic acid for one hour.
10. Vacuole surrounded by granules, from a sixteen-celled sporangium. Cytoplasm shown by stippling. (Fixed.)
- 11 and 12. Parts of wall cells of sporangia showing chains of plastids and granules. Only one focal plane represented. (Living.)
13. Chloroplasts extruded into water and showing vacuoles.
14. Spore with few plastids (the larger bodies) and granules of various sizes. Focal planes shown as in fig. 1 by heaviness of line. (Living.)

O. gracilis.

15. Cell from sporangium at sixty-four-celled stage. Same plan of shading. Paler staining bodies (two) shown very faintly. (Fixed.)
16. Spore with granules of all sizes. Same scheme of shading as for fig. 14. (Living.)

III.—ULTRAFILTRATION.

(An historical survey, with some remarks on membrane preparation technique.)

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Farm Laboratories, Mill Hill).

(Read December 21, 1927.)

WITH THREE TEXT-FIGURES.

THE subject of ultrafiltration is one of great importance in many branches of science, a fact most clearly demonstrated by the wide application its methods have already found in such fields as chemistry, physics, biology, physiology, and bacteriology. Although the literature contains numerous instances of the use of ultrafiltration methods, there is much evidence that there still remains a definite and urgent need for the establishment of a recognised technique, and, further, to emphasise the necessity for a full and complete description of the experimental conditions prevailing during ultrafiltration studies. For true evaluation, for repetition and comparative purposes it is absolutely essential that all records of ultrafiltration results should contain an exact and detailed account of experimental procedure. This, of course, applies to all researches, but especially so in the case of ultrafiltration, where so many inherent variable factors operate. The purpose of the present communication is to indicate the nature of some of these factors as met with in that important phase of the subject, namely, membrane preparation technique, that such remarks as are made may in some way meet the initiatory need of those who may have occasion to utilise ultrafiltration methods.

The general scientific bearing of ultrafiltration follows in consequence of the fundamental nature of the problem with which it deals, and, too, the equally fundamental process involved in the solution of this problem. The problem is that of the separation (which may have to be complete or partial, meaning fractionation) of dispersed particulate material of microscopic and sub-microscopic dimensions from fluid systems—a problem encountered in one phase or another of almost every branch of scientific inquiry. The essential process involved is that of membrane permeability—hence its particular appeal to biologists.

Several types of membrane have been employed for ultrafiltration studies, various animal and vegetable membranes have been used, but mainly artificial gel membranes of collodion, hardened gelatin and silicic acid have formed the septum for the separation of colloid particles from the dispersion fluid. Of these, the membranes from collodion (i.e. a solution of nitro-cellulose in a suitable solvent such as glacial acetic acid or ether-alcohol mixture) are by far the most serviceable and are the ones to be considered in the present paper. Before proceeding to deal with the technique of the preparation of such membranes, a brief historical outline of the subject will be given.

HISTORICAL.

First to recognise the value of collodion as a material suitable for making membranes appears to have been Fick (1855), who recorded diffusion experiments with such membranes. Shortly afterwards Schumacher (1860) described the preparation of collodion sacs, and since that time these, vastly improved in form, of course, have found extensive application, especially in biological and medical investigations. Although easily prepared and very convenient for many purposes such as dialysis and electro-dialysis, the "sac" type of collodion membrane is not ideal for ultrafiltration on account of the lack of uniformity of thickness, which varies at different parts of the "sac." The flat membranes are much to be preferred. The first experiments having the essentials of ultrafiltration technique were those of Martin (1896), who used as an ultrafilter a Pasteur Chamberland candle impregnated with gelatin or silicic acid and conducted filtration experiments with pressures of from 40 to 50 atmospheres. By this means he was able to effect the separation of colloids from crystalloids, and this at once revealed the potentialities of this form of experimental procedure. Bigelow and Gemberling (1907) made a great advance in the technique of preparing ultrafilter membranes. They indicated how it was possible to prepare uniform flat membranes by pouring ether-alcohol collodion on glass surfaces, and also that, by making the membranes on a mercury surface, exceptional constancy and uniformity of thickness could be obtained. Furthermore, their paper contained an excellent bibliography of the subject to that date. In the same year the first of what has now become a classic series of papers by Bechhold (1907) on ultrafiltration appeared. Bechhold was the originator of the name "Ultrafiltration" for the process of filtration through gel membranes, and was the first to obtain a graded series of membranes. This he accomplished by impregnating filter paper with gelatin or acetic acid collodion of varying concentration, the gelatin being hardened by treatment with formaldehyde, while the collodion was "gelled" by washing out the acetic acid with water. Bechhold found that the permeability of his membrane depended upon the concentration of the impregnating solution—the permeability decreased as the concentration increased—and so he was able to obtain a range in permeability. He also worked out methods for deter-

mining the sizes of the pores in ultrafilter membranes, and has since furthered the development of general ultrafiltration methods. Of other investigators who have contributed to the technique of making collodion membranes one may mention Schoep (1911), who indicated that it was possible to increase the permeability of ether-alcohol collodion membranes by adding glycerol in amount varying from 2 to 10 p.c., while the incorporation of 4 p.c. castor oil imparted greater elasticity to the membrane. Brown (1915) obtained graded permeability by preparing air-dried collodion membranes and then tempering them in alcohol of varying water content. The permeability of the resulting membrane was roughly proportional to the alcohol content of the tempering solution. Zsigmondy and Bachmann (1918) have patented a method for preparing a range of membrane filters. The principle underlying the preparation of these membranes appears to be similar to that for ordinary ether-alcohol membranes, a solution of nitro-cellulose in a mixture of two suitable solvents, one of which is relatively volatile, being poured on the horizontal plates and then exposed for a definite period to the influence of a current of moist air, and subsequently washed in water. The permeability of the resulting membrane is governed by the moisture content of the air stream. (*See Colloid Chemistry*, Vol. 1. J. Alexander.) Quite recently Bjerrum and Manegold (1927) have described a satisfactory method for preparing uniformly reproducible ether-alcohol collodion membranes on a mercury surface, and have also derived equations for the permeability of such membranes.

These are the salient contributions to the development of the use of collodion membranes, the preparation of which will now be considered in detail.

PREPARATION OF GRADED SERIES OF COLLODION MEMBRANES.

There are two outstanding methods for preparing a graded series of collodion membranes :—

- (1) The method due to Bechhold, already briefly outlined, in which permeability is varied by altering the concentration of the collodion.
- (2) The ether-alcohol collodion method—the collodion being exposed in a uniform layer upon a glass or mercury surface, then, by arresting evaporation of the solvent at different stages, the permeability of the resulting membrane may be varied.

Each method will be dealt with separately, and experimental procedures described in detail. However, it is necessary, first of all, to give a few preliminary notes in regard to the general preparatory requirements in setting out to use ultrafilter membranes.

1.—*Selection of Nitro-Cotton for Use in Preparation of Collodion for Ultrafilters.*

To prescribe in a precise manner a nitro-cotton suitable for the above purpose is not possible in view of the fact that nitro-cellulose is a product which varies within wide limits. Its particular properties depend upon the nature of the raw material cellulose and also on the conditions under which nitration is carried out. As a guide, however, one may say that a pyroxylin, of nitrogen content approximately 11 p.c. is required. A final decision as to the eminent suitability of any particular specimen can only be arrived at by conducting tests of its solubility (which must be complete) in the solvent to be used, and the production of a good transparent gelatinous film on immersion in water. In view of the points mentioned, it is very necessary to secure an adequate stock of nitro-cotton to meet the full requirements of any proposed ultrafiltration study.

2.—*Treatment of Materials.*

- (a) The nitro-cotton immediately before use is dried to constant weight at 55–60° C. Higher temperatures prove detrimental.
- (b) Glacial acetic acid—obtain best commercial quality—fractionally “freeze out” three times treating an adequate stock in this manner.
- (c) Alcohol is dried over quicklime and then distilled.
- (d) Ether is dried over metallic sodium and distilled.

3.—*Preparation of Nitro-Cellulose Solutions.*

Nitro-cellulose solutions are prepared by weight per cent. and shaken in a mechanical shaker until homogeneous, the actual time and rate of shaking being recorded, since certain characteristics of the solutions (e.g. viscosity) are dependent to some extent upon treatment during preparation.

4.—*Note on Filter Paper to be Used for Impregnated Membranes.*

The filter paper to be used for impregnated membranes should have the undermentioned characteristics :—

- (a) Hardened paper with fine fibres uniformly distributed in the matte.
- (b) Smooth surface.
- (c) Uniformity of thickness throughout the batch.

These points are very important, since the reproducibility of impregnated membranes depends to quite an appreciable degree upon the consistency of the paper used. Bechhold recommends the use of Schleicher and Schull No. 575 or 602, and the author, after carefully examining several varieties microscopically, decided to use Schleicher and Schull No. 575 as most nearly satisfying the above requirements. (See fig. 1, which illustrates the arrangement of cellulose fibres in filter paper.) Should this paper, however, not be available, Whatman No. 50 will be quite an efficient substitute.

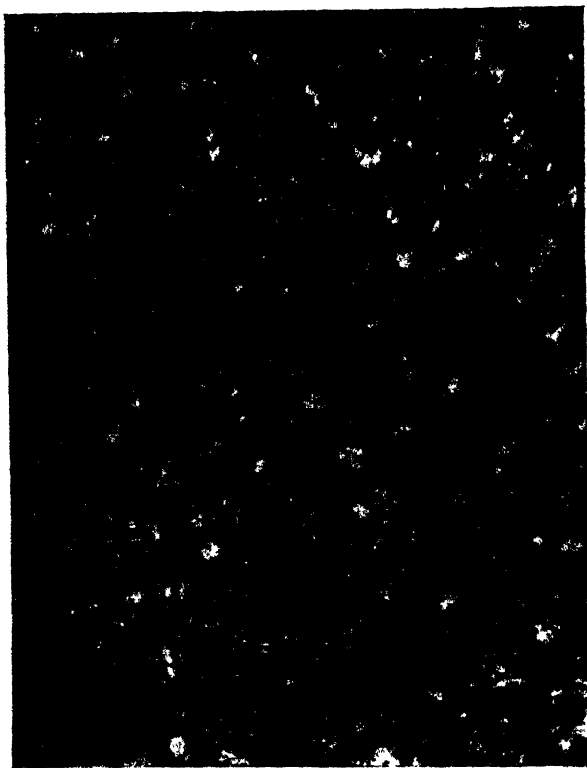


FIG. 1.—Schleicher and Schödl. Filter Paper No. 575.
($\times 100$)

PREPARATION OF IMPREGNATED ACETIC ACID COLLODION MEMBRANES.

Literature : Bechhold (1907, 1908).

Method 1.—Filter paper discs with tab (as illustrated in fig. 2) are treated with acetic acid by the method of vacuum impregnation outlined in Method 2. After withdrawing discs from the acid, they are drained for one minute and then transferred to another vessel connected via Wolff's bottle containing sodium hydroxide solution to a manometer and water pump, and kept evacuated for one hour. All discs are treated in exactly the same way, and the fibres are consequently more readily wetted by the collodion and the impregnation process thereby facilitated. The discs are immersed in the collodion contained in a petri-dish in a vacuum desiccator and the air withdrawn from the paper by exhausting. The subsequent procedure on withdrawing the discs from the collodion is the same as in Method 2. The present method has a serious defect, namely, the loss of solvent during the "exhausting period" and the consequent alteration in the concentration of

collodion. The magnitude of this factor increases with the more viscous solutions, the removal of the air bubbles taking much longer times. To obtain anything approaching reproducibility of results the following points must be rigidly observed :—

- (a) Always use the same volume of collodion in a petri-dish of definite diameter.
- (b) Have a definite "exhaustion period" for each nitro-cotton solution and also a definite "vacuum."
- (c) Have a definite "draining time" on removal of membranes from the solution.

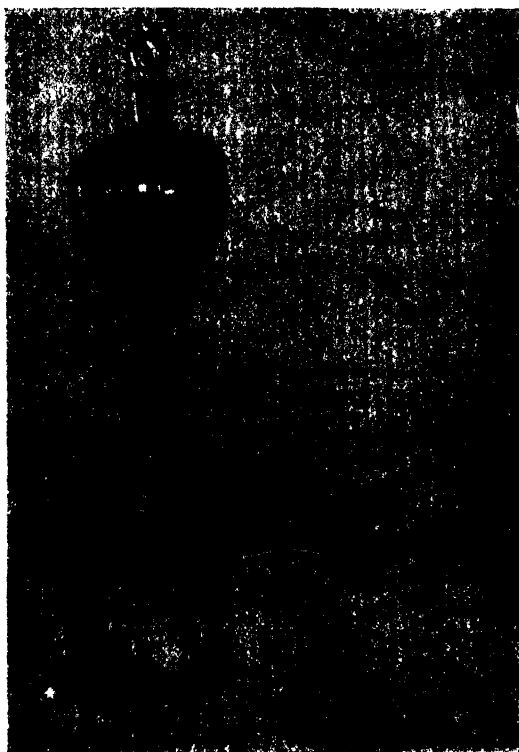


FIG. 2.—A simple efficient form of apparatus for impregnating filter discs.

Method 2.—Vacuum impregnation. This is the method advised by Bechhold for all accurate work, and is certainly to be recommended, in preference to Method 1, as being productive of uniformly consistent results. A very simple and efficient form of apparatus for this method is shown in fig. 2. The discs are suspended on a glass support and separated one from the other by glass beads. The chamber containing the discs is evacuated and the collodion then admitted from the upper

vessel. When the discs have been immersed for fifteen minutes, air is admitted via the side stopcock, and impregnation allowed to proceed under atmospheric pressure. The discs are left so for at least one hour—a longer period is advisable in case of the more viscous solutions. Quoting Bechhold: "After the filter discs are removed from the glacial acetic acid collodion, each individual filter is allowed to drip while being constantly turned." To obtain good reproducibility this operation has to be conducted with extreme care to ensure the same draining in each case. Besides the difficulty in securing reproducible draining, another objection is that during the rotation the collodion tends to accumulate at the edge of the filter. Thus good uniformity of thickness is seldom obtained. Again, the mean thickness of the membranes prepared in this way increases with the viscosity of the collodion. Hence accompanying the decrease in permeability of the membrane with higher concentrations is the increase in thickness, which is most undesirable; for increase in thickness means retarded rate of filtration and also an augmented adsorption factor. Adsorption, especially in filtration of biological fluids, has to be given careful consideration in ultrafiltration experiments. With a view to minimising these undesirable effects, the author has employed a very simple procedure. The filter discs, when withdrawn from the collodion, are slowly drawn horizontally between two fixed glass rods (each $\frac{3}{4}$ in. diameter) which are kept at a definite distance apart by means of nickel wire of known gauge. The discs are then immediately immersed in distilled water for "gelation" and washing. This procedure has given most gratifying results, and the membranes throughout the entire concentration range are of the same order of thickness, 0.15 mm.

Washing of Membranes.

A satisfactory procedure is to wash the membranes in changes (twice daily) of distilled water for ten to fourteen days.

The careful observance of the various technical points that have been mentioned enables impregnated glacial acetic acid collodion membranes of good reproducibility to be prepared.

ETHER-ALCOHOL COLLODION MEMBRANES

(E.A.C. MEMBRANES).

Literature: Bigelow and Gemberling (1907); Bartell and Carpenter (1923); Bjerrum and Manegold (1927).

A convenient solution for use in preparing membranes by the method to be described is 1.5 p.c. or 2.0 p.c. of the nitro-cellulose in a mixture of ether and alcohol in the ratio 75 : 25 respectively by weight. A large bulk of solution should not be made, owing to the volatile nature of the solvent.

The following is the procedure employed by the author and has been found quite satisfactory. The accompanying fig. 3, which is self-explanatory, gives in section the preparation chamber. The action of the water-pump is just sufficient to ventilate the chamber without creating a draught. Bjerrum and Manegold use a fan rotating at constant speed for this purpose. The undermentioned technical points must be strictly adhered to for reproducible membranes to be obtained.

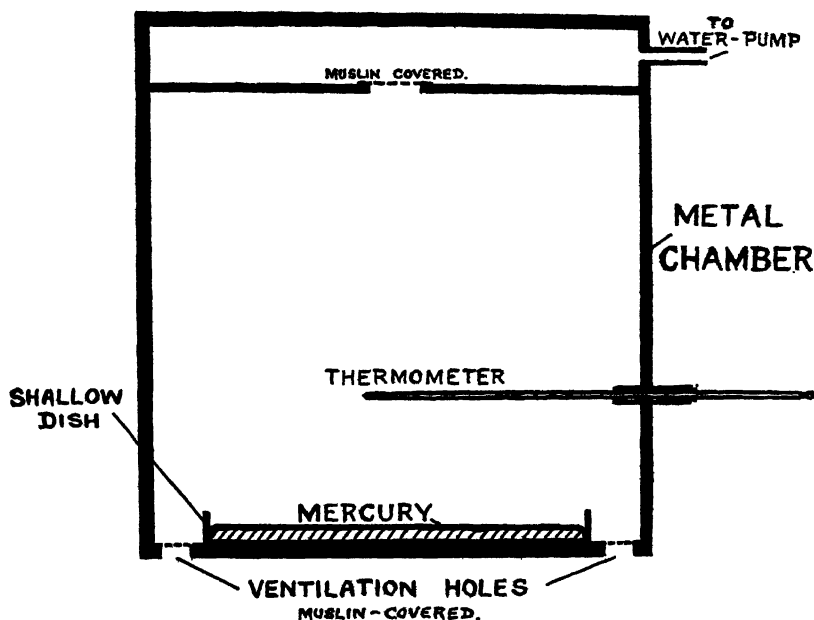


FIG. 3.—Chamber (in section) for preparation of ether-alcohol collodion membranes on a mercury surface.

(a) Always use a definite volume of carefully cleaned dry mercury in the shallow dish, which must be of the same size in all experiments. A glass surface may be used instead of mercury, but requires to be adjusted perfectly horizontally. The mercury surface, of course, is self-adjusting, and herein lies the secret of the wonderful uniformity of membrane thickness obtained.

(b) Pour a measured volume of collodion (the same in all experiments) on to the mercury surface.

(c) Allow evaporation to proceed for a definite time, at the end of which distilled water is poured to cover the collodion film, which quickly gels and can then be readily transferred to the trough for complete washing. In determining the evaporation period for a given nitro-cotton solution, the first step is to conduct a preliminary experiment, examining the collodion layer at intervals. The time is recorded when the collodion surface has

just set, as indicated by its no longer sticking to the finger when lightly touched. This gives the minimum evaporation interval, and the film, when fixed with water as indicated above, yields the most permeable membrane. Then, by progressively increasing the time allowed for evaporation, a series of membranes decreasing in permeability can be obtained.

(d) Always record the temperature of the chamber during the evaporation period.

(e) Wash membranes in distilled water, making changes twice daily for a fortnight.

CHARACTERISTICS OF E.A.C. MEMBRANES.

1. These membranes are surprisingly strong. Tensile strength measurements, using test pieces 6 cm. long by 1.5 cm. wide, showed the breaking tension to increase from 0.70 kilogram to 1.50 kilogram in a series of membranes 0.75H to 3.0H. (Note nomenclature 0.75H membrane means a membrane whose evaporation period was three-quarters of an hour—3.0H meaning three hours and so on.)

2. The membranes prepared on mercury exhibit a wonderful uniformity of thickness, and by preparing a large flat membrane from which smaller ones can be cut with a die, a number of membranes with identical properties can be obtained. In these respects, uniformity of thickness, pore size and distribution of pores, these membranes are far superior to the impregnated membranes, where the presence of the cellulose fibres undoubtedly influences the structure, introducing strains and distortions.

3. The thickness of membranes in a graded series decreases as the evaporation time increases, i.e. with decrease in permeability. (c.f. impregnated membranes.)

4. The general permeability of E.A.C. membranes is less than that of glacial acetic acid collodion membranes.

MEANS OF MODIFYING THE PERMEABILITY OF E.A.C. MEMBRANES.

1. Increasing the evaporation time decreases the permeability.

2. Alteration of ether-alcohol ratio in solvent. Convenient ratios are E : A = 75 : 25 ; or 50 : 50 or 25 : 75. The general permeability of series of membranes is greater the higher the alcohol content of solvent.

3. Incorporation of materials :

(a) Water—Increases Permeability.

(b) Acetone " " "

(c) Glycerol " " Schoep (1911).

(d) Castor Oil and Acetic Acid improve elasticity and durability of the membranes, as shown by Schoep (1911) and Eggerth (1921) respectively.

However the degree to which these substances modify the characteristics of the resulting membranes depends upon the nature of the nitro-cellulose and can only be determined by experiment.

Although there can be no doubt as to the superiority of the ether-alcohol collodion membranes from the point of view of structure, to obtain a graded series of such membranes over the range covered by the impregnated glacial acetic acid membranes (order of pore size 1μ to $10\mu\mu$) entails a lot of preliminary standardisation, necessitating the adjustment and readjustment of the various factors already mentioned. The recommendations of the glacial acetic acid collodion membranes lie in their greater general permeability and the ease with which a graded series may be prepared.

The account that has been given of ultrafiltration membrane preparation technique will, it is hoped, achieve its purpose in familiarising the investigator who would avail himself of the use of these methods with the essential points of this aspect of the subject.

REFERENCES.

- BARTELL and CARPENTER (1923).—*J. Phys. Chem.* **27**, 101.
BECHHOLD (1907).—*Zeit. f. physikal. Chemie.* **60**, 257. (1908.) **64**, 328.
BIGELOW and GEMBERLING (1907).—*J.A.C.S.* **29**, 1576.
BJERRUM and MANEGOLD (1927).—*Koll. Zeit.* **42**, 97. (1927.) **43**, 5.
BROWN (1915).—*Biochem. J.* **9**, 591.
EGGERTH (1921).—*J. Biol. Chem.* **48**, 201.
FICK (1855).—*Pogg-Ann.* **94**, 59.
MARTIN, C. J. (1896).—*J. Physiol.* **20**, 364.
SCHOEP (1911).—*Koll. Zeit.* **8**, 80.
SCHUMACHER (1860).—*Pogg-Ann.* **110**, 337.
ZSIGMONDY and BACHMANN (1918).—*Zeit. f. Anorg. Chemie.* **103**, 119.

IV.—DESCRIPTION OF A CONVENIENT TABLE FOR MICROSCOPY.

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University of Cambridge.

(Read February 15, 1928.)

WITH ONE PLATE.

THE following description is of a table which I designed several years ago, and which has stood the test of experience during that period. Inasmuch as it has attracted the interest of a number of colleagues visiting the laboratory, publication of the details of its construction would appear to be warranted.

The table is a plain four-legged one of ordinary height. The top is rectangular, 36 in. by 20 in. in dimensions. Practically the entire wooden top is covered by a sheet of plate glass a quarter of an inch thick. A marginal strip of an inch and a half wide all round is left uncovered by the glass plate, which thus itself measures 38 in. by 17 in. On this marginal strip are screwed wooden fillets of the same thickness as the glass, so that the entire surface of the table is flush. The glass sheet is separated from actual contact with the wooden top by a sheet of thick white blotting-paper (whose thickness should be allowed for in preparing the marginal wooden fillets). If desired, a part of the whole area may be bedded on black instead of white paper.

A circular aperture, 3 in. in diameter, is cut in the wooden top (and in the blotting-paper) in a position which is to be directly under the optical axis. Preferably this aperture should be a little to the left of the centre of the table, and the centre of the aperture should be approximately $4\frac{1}{2}$ in. from the near or front margin of the table top. The 3-in. hole in the table is not cut to that size right through, but a narrow rebate is left at its lower periphery in order to support the edge of a cheap 3-in. hemispherical* condenser, which is dropped into the hole with its convexity upwards. In addition, a square of daylight glass, $3\frac{1}{2}$ in. or 4 in. square, is slid into position below the condenser, flush with the under surface of the table top, between retaining rebated fillets of wood.

An electric lamp with opal bulb—I use a 100 watt, but a 60 watt would probably be quite adequate—is carried on an adjustable fitting attached

to the under surface of the table top. The lamp is adjustable vertically to fit the focus of the hemispherical condenser.

By this method the whole aperture is flooded with light of very fine quality. If it is desired to limit the extent of this rather large illuminated area, this can readily be done by inserting an annular diaphragm of black cardboard beneath the condenser, which can be easily removed for the purpose after raising the glass top from its bed.

At first I found that the heat of the lamp, in the vicinity of the thigh and knee, was a slight inconvenience, but this was entirely obviated by a wooden screen or shield of appropriate shape and size screwed to the under surface of the table top in front of the lamp. (If I were about to construct another table, I should be disposed to experiment with the lamp placed towards the back of the under surface of the table top and with a plane mirror of suitable size secured under the circular aperture in the table at a fixed angle of 45° . This might, I imagine, give practically identical, if somewhat weaker, illumination, though a longer focus condenser might be required. But I have found the present arrangement so eminently satisfactory that I have not troubled to attempt any modification of it.)

Although the table lends itself admirably to use with the ordinary compound microscope with the substage mirror removed, I have not hitherto utilised it habitually for this purpose. It was, in fact, specially designed, and I have practically solely employed it, for use with the stereoscopic binocular microscope of the Greenough type. Its construction was prompted by experience of the difficulty of filling equally both fields of such a microscope by means of the small mirror from an artificial illuminant. The substitution of the expedient here described proved a conspicuous success.

Whilst the ordinary Greenough stand may quite well be employed with this table, its full value cannot thus be exploited. I now use only the binocular body of a Greenough microscope supported on the simple Zeiss type of pillar-support.* Used in this way the entire glass top of the table is at the normal stage level, the base of the Zeiss pillar being fixed by its own milled-head screws to a metal fitting let into the wooden marginal fillet along the near side of the table top. The pillar can readily be unshipped by simply unscrewing these thumbscrews.

Further, the pillar can be left in position and the binocular body detached from it and replaced by the Drüner stereoscopic camera, for photomicrographic purposes, without any disturbance of an object left in position to be photographed.

The microscope table above described permits of the examination of slides or objects of any size. Petrie or other glass vessels containing specimens for examination in fluid can be utilised and can be moved about

* Zeiss pillar bracket No. 9.

freely without any stage limitation whatsoever. The whole glass table top is the microscope stage.

Plainly such a table would be incomplete without provision for the alternative top-lighting of opaque objects by incident light. Such episcopic illumination is easily arranged for from any convenient source. I employ a long universal-jointed arm carrying an electric bulb and mounted on a heavy foot placed at the back right-hand corner of the table. Preferably, however, the long jointed arm should be securely fastened to the back of the table top, dispensing entirely with the heavy foot. A double switch conveniently fitted to the right-hand end of the table below the level of the top permits of the instant substitution of episcopic for diascopic illumination of the field, or for both, though this is usually superfluous and mostly undesirable. A bull's-eye condenser is generally useful as an accessory to episcopic illumination, and this may of course, either form part of the fitting of the episcopic lamp or may be employed as a separate movable adjunct. On the whole, it is well to keep the table clear of all impedimenta in the shape of separate apparatus.

EXPLANATION OF PLATE.

FIG. 1.—General view of microscope table with binocular prism microscope body on removable pillar. Also lamp for illumination of opaque preparations, with which a bull's-eye condenser may be used if desired.

N.B.—The circular sub-illuminated field of the glass top is barely discernible at this angle of view.

FIG. 2.—View of under side of microscope table showing the lamp on its adjustable fitting; the wooden rebated fillets between which a plate of daylight glass is slid into position; wooden shield for protection of observer's body from heat of lamp.

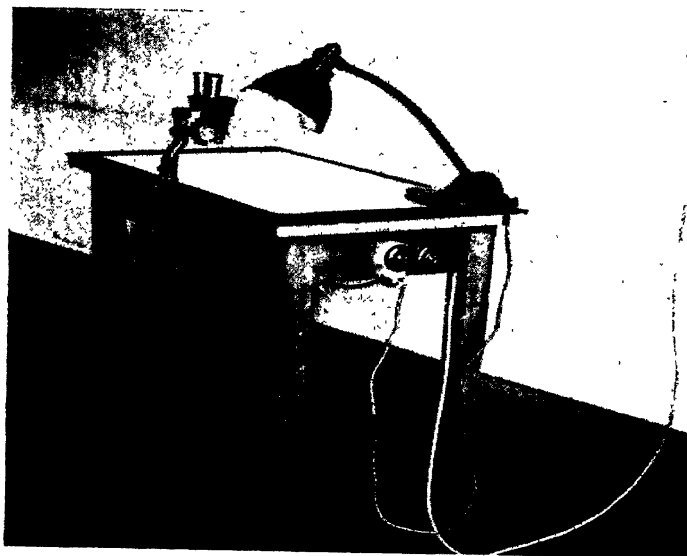


FIG. 1.

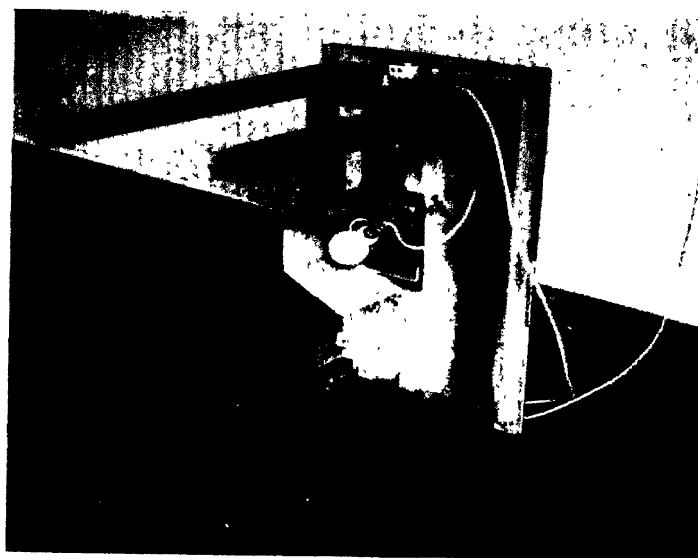


FIG. 2.

OBITUARY.

JOHN RUDD LEESON, F.R.M.S. 1854-1927.

It is with great regret we have to record the death of Dr. Leeson, who, until the last two or three years, had been a fairly regular attendant at our meetings, at which he often spoke. He also gave several interesting papers to the fellows on microscopical subjects, his genial and open manner making him well known and very popular with the Fellows.

Dr. Leeson was the only son of John Leeson, of Davis Street, Berkeley Square. He studied at St. Thomas's Hospital and at the Universities of Edinburgh, Vienna, and Berlin. He also worked under the late Lord Lister for two years. (Last year, in April, Dr. Leeson published a book "Lister as I Knew Him.") After this he became House Physician at St. Thomas's Hospital, and later demonstrator of anatomy in the Medical School. In 1879 Dr. Leeson settled at Twickenham, acting as medical officer of St. John's Hospital for twenty-nine years. He served on the old Local Board and Urban District Council for many years, and became Chairman of the Council in 1912. During the war he served as hon. medical officer to the Auxiliary Hospital, Isleworth, also as captain in the R.A.M.C.T. He filled many important positions in Twickenham, including that of Charter Mayor, which position he held at the time of his death.

Dr. Leeson was a Doctor of Medicine, Master of Surgery of the University of Edinburgh, a member of the Royal College of Surgeons of England, Fellow of the Linnean Society, the Royal Astronomical Society, The Royal Microscopical Society, a member of the Royal Institution and other scientific bodies, a member of the Athenæum and a Liveryman of the Salters Company.

Dr. Leeson died at Clifden House, Twickenham, on October 28, aged 73.

C. D. S.

ABSTRACTS AND REVIEWS.

ZOOLOGY.

(Under the direction of G. M. FINDLAY, M.D.)

STAINING AND IMPREGNATION METHODS.

Neutral Red and Paramœcium.—C. N. WILSON ("A Comparative Study of Several Samples of Neutral Red and their Effects on *Paramœcium caudatum*," *Stain Technol.*, 1927, 2, 115-23). Various samples of neutral red vary in physical characters both in the dry form and in solution. The duration of life of groups of Paramœcia also varies in each dye solution, probably owing to differences of chemical composition.
G. M. F.

A Review of Recent Developments in Histochemistry.—M. PARAT (*Biol. Reviews*, 1927, 2, 285-97). The subjects dealt with are the histochemistry of the proteins and their derivatives, fats, iron, phosphorus and calcium. There is an excellent bibliography.
G. M. F.

An Iron Impregnation Method Especially Applicable to the Reticulo-Endothelial System.—P. DEL RIO HORTEGA ("Fundamentos y reglas de una técnica de impregnación férrica, aplicable especialmente al sistema reticulo-endotelial," *Bol. de la Real Soc. españ. de Hist. Nat.*, 1927, 27, 372-83). The various techniques for demonstrating iron in normal and pathological tissues are discussed. The following technique is employed, frozen sections of 20 to 25 μ thickness from material which has only been fixed for a short time, being employed:—

(1) Place the sections for ten minutes in ammonia water (20 drops of ammonia in 30 c.c. of distilled water).

(2) Wash thoroughly.

(3) Treat for some minutes either in the cold or warm with a 10 c.c. solution of hydrochloric acid.

(4) Impregnate in the following solution:—

Freshly prepared 10 p.c. solution of potassium ferricyanide, 45 c.c. ;

10 p.c. solution of hydrochloric acid, 55 c.c.

The sections should be placed in the solution, which is gently warmed to 60-65° C. and at the same time agitated. The sections are removed when the liquid begins to lose its transparency.

(5) Wash in a 1 p.c. solution of sodium carbonate until the sections become flexible and transparent.

(6) Wash in a 1-10 p.c. solution of hydrochloric acid. For tissue which only contains iron in physiological amounts, proceedings (4), (5) and (6) should be repeated twice.

The technique ends by thoroughly washing the sections and counterstaining either with acid fuchsin or eosin, in the latter case followed by differentiation in 95 p.c. alcohol.

G. M. F.

The Evaluation of Ethyl-Eosin.—W. C. HOLMES and J. T. SCANLAN (*Stain Technol.*, 1927, 2, 101-3). Suitable methods for determining eosin and ethyl-eosin in samples of the latter dye depend upon the possibility of precipitating the colour acid and measuring it gravimetrically. What proportion of the dye is ethyl-eosin and what proportion eosin can be determined by making use of the great difference in solubility of the two dyes in water.

G. M. F.

Germicidal Effect of Staining Solutions.—G. A. ECKFELDT and S. A. KOSER (*Stain Technol.*, 1927, 2, 109-14). Gentian violet, crystal violet, and carbol fuchsin applied to coverslip preparations for one minute will destroy the majority of non-spore-forming bacteria and yeasts, though they cannot be relied upon to do this in all cases. The Gram staining procedure always kills non-spore formers. Methylene blue exerts very little and India ink no germicidal action.

G. M. F.

Progress in the Standardisation of Stains.—H. J. CONN (*Stain Technol.*, 1927, 2, 97-100). Samples of brilliant cresyl blue show decided variations in staining capacity, and it has not yet been possible to correlate them with differences in chemical composition. The same applies to cresyl violet and brilliant green. Several staining procedures specify the use of alcohol soluble eosin, e.g. in demonstrating Negri bodies in rabid animals. Ordinary yellowish eosin-water soluble eosin is also soluble in alcohol, and the colour acid of this dye is soluble in alcohol, but not in water. Both these products are sold under the name of alcohol soluble eosin, but neither is satisfactory for the demonstration of Negri bodies. The methyl or ethyl ester of yellowish eosin is more correctly known as alcohol soluble eosin. These esters are readily soluble in alcohol and boiling water, but not in cold water. They give cherry red solutions without appreciable fluorescence, and are both suitable for demonstrating Negri bodies.

G. M. F.

Extinction Coefficients of Dyes.—R. W. FRENCH (*Stain Technol.*, 1927, 2, 124-5). Extinction coefficients (k) or specific transmissive indices, as determined spectrophotometrically, are necessary in a quantitative study of dye-stuffs with a spectrophotometer. Such data are constant for a given dye in a given concentration and solvent when examined in a layer of a certain thickness. Ten parts of dye in a million of solvent with a cell depth of 1.0 cm. is used as a standard. By this means with stains of known identity the extinction coefficient is a criterion of dye content, while with stains of unknown character, whose dye content can be determined by some other method, it is possible to establish the nature of the dye. The extinction coefficients of nineteen dyes are given.

G. M. F.

GENERAL CYTOLOGY.

Oögenesis in *Limulus Polyphemus*.—M. S. GARDINER ("Oögenesis in *Limulus polyphemus*, with especial reference to the behaviour of the nucleolus," *Journ. Morph. and Phys.*, 1927, 44, 217-66, 2 pls., 19 figs.). The nucleolus arises by the confluence of substance which passes from the cytoplasm into the nucleus, and it is suggested that the mitochondria, and possibly also the Golgi bodies, are derived from an excess of this substance which accumulates in the cytoplasm. Mitochondria and Golgi bodies are not present in the oögonia, but appear first in oöcytes after the formation of the nucleolus is completed. During oögenesis the

nucleolus is very active, and the greater part of its substance is passed back to the cytoplasm. The nucleolar extrusions effect the transport of phosphorus from the nucleus to the cytoplasm, where it is used in the synthesis of yolk. The definitive yolk arises by the interaction of nucleolar extrusions, mitochondria, Golgi bodies, and ground cytoplasm.

R. J. L.

Spermatogenesis in the Belostomatidæ.—A. M. CHICKERING ("II. The Chromosomes and Cytoplasmic Inclusions in the Male Germ Cells of *Belostoma flumineum* Say, *Lethocerus americanus* Leidy, and *Benacus griseus* Say," *Journ. Morph. and Phys.*, 1927, 44, 541–607, 7 pls., 153 figs.). There are 8 spermatogonial chromosomes in *Lethocerus americanus*, 24 in *Belostoma flumineum*, 28 in *Benacus griseus*. An X–Y pair of sex chromosomes occurs in each species. These are identifiable at every step in maturation in *Lethocerus*, but not in the others. A clear case of heteropycnosis occurs in *Benacus*. Parasygnapsis is believed to be the mode of pairing of chromosomes in all three species. Spermatogonial chondriosomes are always granular. During the growth period filaments are formed, probably by fusion of granules, and these are sorted out in approximately equal numbers to spermatids. Golgi bodies are minute granules in spermatogonia. During the growth period each becomes a flattened plate-like body clearly differentiated into two materials. Dictyosomes are formed by fragmentation in the first prophase, and these are distributed to spermatids where they fuse to form an acroblast in each.

R. J. L.

Chromosomes of Norway and Black Rat.—G. PINCUS ("A Comparative Study of the Chromosomes of the Norway Rat (*Rattus norvegicus* Erxl.) and the Black Rat (*Rattus rattus* L.), *Journ. Morph. and Phys.*, 1927, 44, 515–40, 66 figs.). *Rattus rattus* has 40 diploid chromosomes and *R. norvegicus* 42. Both species have an unequal pair in the spermatogonial divisions, and the finding of a similar unequal pair in the first spermatocyte division constitutes the evidence for an X–Y mechanism in each. A comparison of the morphology of the first spermatocyte tetrads in the two species reveals the presence of a large K-shaped chromosome in *R. norvegicus* which is not present in *R. rattus*. Furthermore, a comparison of the X–Y complex in both the spermatogonial and the first spermatocyte divisions shows that these are morphologically different in the two species, the Y in particular being markedly dissimilar in size.

R. J. L.

Gametogenesis of Sponges.—J. B. GATENBY ("Further Notes on the Gametogenesis and Fertilisation of Sponges," *Q.J.M.S.*, 1927, 71, 173–88, 3 pls.). This paper is an extension of work previously carried out by the same author on gametogenesis and fertilisation of sponges. All the early stages of fertilisation which he had been unable to find previously are described in the present paper. The "chronidia" of Dendy are regarded as mitochondria. A remarkable process of fragmentation of the choanocyte mitochondria to form peculiar spheres is described. It is believed that spermatogenesis in *Grantia compressa* may take place in two ways. Firstly, from definite pockets of cells, lined by large cells, lying in the matrix. Such areas are regarded as testes. Secondly, from a direct rapid metamorphosis of collar-cells into spermatocytes.

R. J. L.

Colloid Chemistry of Protoplasm.—L. V. HEILBRUNN ("The Colloid Chemistry of Protoplasm. (V.) A Preliminary Study of the Surface Precipitation Reaction of Living Cells," *Arch. f. exp. Zellforsch.*, 1927, 4, 246–63, 1 pl.). In many cells, though not in all, naked protoplasm, when forced out of a cell, forms a film about itself. In *Arbacia* eggs the reaction is retarded by cold, but not inhibited

by fat solvents. Calcium is necessary ; strontium can act as a substitute, but not magnesium nor barium. The pigment granules of the egg break down, and this is an essential part of the reaction, since in centrifuged eggs no surface precipitation reaction occurs on the side of the egg away from the pigment granules. In *Echinarachinus* eggs the place of the pigment granules is taken by other large granules. By extracting smashed sea-urchin eggs it is possible to obtain a substance "ovothrombin" which can produce a surface precipitation reaction in the absence of calcium.

G. M. F.

Molluscum contagiosum.—E. W. GOODPASTURE and H. KING ("A Cytologic Study of *Molluscum contagiosum*," *Am. J. Path.*, 1927, 3, 385-94, 2 pls.). A cytological description of the development of the molluscum bodies in this infective skin disease of man is given. The first sign of virus infection in the epidermal cells is a minute vesicle to which a minute granule is attached. The vacuoles become uniformly filled with minute discrete bodies which stain pink with acid fuchsin. Eventually the vacuoles fuse together to form an intracellular mass which undergoes hyalinisation. Neither extruded nucleoli nor mitochondria play a part in the formation of the elementary bodies.

G. M. F.

Migration of Neutrophilic Leucocytes.—W. H. LEWIS (*Archiv. f. exp. Zellforsch.*, 1927, 4, 1 pl.). When neutrophil leucocytes migrate, the broad anterior end extends out into tufts of thin wavy film-like pseudopodia, while the posterior end is narrower and has projecting backward several long, slender, pointed processes. Contraction waves start at the anterior end near the base of the tuft of pseudopodia. Brownian movement is seen in the endoplasm at this part, indicating that it is more fluid here than elsewhere.

G. M. F.

Giant Cells.—W. H. LEWIS ("Formation of Giant Cells in Tissue Cultures," *Trans. National Tuberculosis Assn. of America*, 1926, 260-64). The formation of giant cells was studied in tissue cultures of a rat sarcoma. The nuclei of the giant cells divided both by mitotic and amitotic division, but there was no evidence of fusion of cells.

G. M. F.

Physical Relation of Cells.—F. E. KREDEL ("The Physical Relation of Cells in Tissue Cultures," *Bull. Johns Hopkins Hospital*, 1927, 40, 216-27, 1 pl.). Evidence is brought forward to show that the cells in the tissues of the chick are anatomically independent. The effect of mechanical injury at the surface of the cell is transmitted rapidly through the cell, but does not appear to affect adjacent cells. As it coagulates, an injured cell loses its adhesiveness for other cells, a fact indicating the importance of surface tension in the natural adhesiveness of cells. In the chick, cells of mesenchyme, amniotic ectoderm, smooth muscle, endoderm of the intestine, liver, endothelium and epithelium of the skin, are therefore held together by simple adhesion and not by fusion nor by intercellular protoplasmic bridges.

G. M. F.

Giant Cells in Tissue Culture.—W. H. LEWIS ("Binucleate Cells and Giant Cells in Tissue Cultures, and the Similarity of the Latter to the Giant Cells of Tuberculous Lesions," *Tubercle*, 1927, 8, 317-330, 1 pl.). The factors responsible for giant cell formation are not definitely known. Contact with foreign bodies, substances produced by tubercle bacilli and deficient oxygen are possible factors, though the data in support of the last are not convincing. There is no apparent reason why certain uninuclear cells of similar type should fuse with a small giant cell while other similar cells in contact with the giant cell do not fuse with it.

G. M. F.

Tissue Culture of Jensen's Rat Sarcoma.—H. B. FELL and J. A. ANDREWS ("A Cytological Study of Cultures, 'in vitro' of Jensen's Rat Sarcoma," *Brit. J. Exp. Path.*, 1927, 8, 413–28, 7 pls.). Tissue cultures of Jensen's rat sarcoma were made in a culture medium consisting either of serum from a sarcoma-bearing rat or of a mixture of this serum and chicken plasma. Cultures grown in serum alone showed less extensive outwandering, much fewer mitotic figures, and died out more rapidly than cultures grown in a mixture of rat serum and chicken plasma. Two types of cells were present in the cultures and occurred in about equal numbers: (a) cells resembling fibroblasts, and (b) smaller wandering cells similar to clasmato-cytes. At present it is not known which is the malignant cell, though, by analogy with Carrel's experiments on the Rous sarcoma, the wandering cell or clasmato-cyte may be the malignant component, the fibroblast-like cells representing stromal elements. The cytology of the two types of cell is described. The wandering cells contained more fat globules and cell granules than the fibroblasts, from which they also differed in the complex arborescent form which they assumed on emerging from the explant. In cultures studied on the warm stage by dark ground illumination it was found that the wandering cells were far more motile than the fibroblast-like elements, and the movements of the various cytoplasmic inclusions were also considerably more active. Giant centrospheres occurred in the fibroblast-like cells of old serum cultures. Binucleate cells were common, while multinucleate cells containing as many as 40 nuclei of very varied sizes also occurred. Cells resembling epithelioid cells were abundant in certain cultures; they seemed to be formed from the wandering cells and to be of a degenerate character. In old serum cultures a certain proportion of the cells hypertrophied, sometimes enlarging to seven or eight times their original size.
G. M. F.

Arbacia Fertilisation and Ultra-Violet Radiation.—M. A. HINRICHES ("Ultra-Violet Radiation and the Fertilisation Reaction in *Arbacia punctulata*," *Biol. Bull.*, 1927, 53, 416–37, 3 text-figs.). The radiation of normal eggs produces a gradual and finally a complete loss of the power of producing fertilisin. There is a parallel loss of viability of the eggs as measured by their fertilisability and ability to develop normally. Sea water which has been in contact with irradiated eggs, "egg-water," loses first its agglutinating power and then its sperm-stimulating power. There is an optimum pH range around the neutral point for the agglutinating action of egg-water. Ultra-violet radiation produces a slight increase in the pH of egg-water. Radiated sperms undergo a reduction of agglutinability by normal egg-water.
G. M. F.

Carbon Dioxide as a Narcotic Agent.—C. HAYWOOD ("The Effect of Carbon Dioxide upon the Fertilised Egg of *Arbacia*," *Biol. Bull.*, 1927, 53, 450–64). Small amounts of carbon dioxide in sea water delay the first cleavage of the fertilised eggs of *Arbacia*, while greater amounts of CO₂ than those corresponding to a 40 p.c. saturation almost entirely suppress it. Since a very considerable oxygen deficiency causes only a slight delay in the cleavage process, the factor of oxygen lack is probably a negligible one. The effects of a complete suppression of the cleavage process in sea water practically saturated with carbon dioxide are readily reversible up to exposures of 20 minutes. Beyond that point abnormalities may appear, though after exposures of two and a half hours 95 to 100 p.c. of the eggs ultimately divide.
G. M. F.

A. VERTEBRATA.

Embryology, Evolution, Heredity, etc.

Hermaphrodite Tortoise.—R. MATTHEY ("Intersexualité chez une tortue (*Emys europæa*)," *C. R. Soc. Biol.*, 1927, 97, 369). Very few cases of hermaphroditism in reptiles have been described, which makes this example especially interesting. This male tortoise had a well-developed and normal right testis and epididymis. The left gonad was a long narrow oötestis, with several oöcytes of various sizes at the anterior end. The left epididymis was normal, but smaller than the right, and the penis was normal. Two oviducts, similar to those of a young female, were present, the left with numerous swellings upon it. Histologically the oötestis exhibited intense spermatogenesis, but few spermatozoa and little or no oögenesis. The right testis was normal, and both epididymi were full of spermatozoa. He considers that the few oöcytes present in the oötestis and the absence of oögenesis show that a female phase once predominated.

F. W. R. B.

Secondary Sexual Characters.—K. PONSE ("Territoires cellulaires et caractères sexuels secondaires," *C. R. Soc. Biol.*, 1926, 95, 950). Mlle. Ponse replaced a portion of the skin of the nuptial pad of a number of toads by a skin graft from a hind toe, and *vice versa*. In those cases where the grafts grew, the skin from the nuptial pad retained its characteristics, as did that from the hind toe. This confirms the work of previous investigators, and is claimed to show that the cells of the nuptial pad have a specific power of reacting to the genital hormones irrespective of innervation and position.

F. W. R. B.

Bidder's Organ in Toads.—K. PONSE ("Les potentialités de l'organe de Bidder des crapauds," *C. R. Soc. Biol.*, 1927, 96, 595). Mlle. Ponse has followed up her previous experiments on the transformation of Bidder's organ into an ovary in the male toad following castration. She removed the ovaries from a large number of female toads. Some of these regenerated ovarian tissue during the first year, obviously from fragments of ovary not removed, as Bidder's organ remained unchanged. During the second and third years others exhibited changes in Bidder's organ which ultimately amounted to transformation into true ovaries. Some of these animals laid eggs, which segmented, but were obviously abnormal. These experiments show that Bidder's organ in the female, as well as in the male, is capable of transformation into an ovary and of producing eggs capable of development. She considers that the organ is an atypic ovary, arrested in development by the presence of functional gonads, either ovaries or testes.

F. W. R. B.

Origin of Germ-Cells.—R. R. HUMPHREY ("Extirpation of the Primordial Germ-Cells of *Amblystoma*: its Effect upon the Development of the Gonad," *Journ. Exp. Zool.*, 1927, 49, 363-400, 5 pls., 2 text-figs.). The primordial germ-cells in early stages of *Amblystoma* are situated in the lateral mesoderm immediately below the Wolffian duct and between somites 7 and 16. Humphrey removed them from one side by excising this strip of mesoderm together with the Wolffian duct and the overlying ectoderm. More than half the embryos survived after this treatment and were kept alive for long periods. In some cases stray germ-cells were missed which later gave origin to nodules of gonad-tissue on the operated side. In many cases they appear to have been completely removed, for no germinal ridge was subsequently formed on that side, and in consequence germ-cells were

not reformed later. In other cases, not yet fully described, Humphrey states that a sterile germinal ridge was formed on the operated side, in which germ-cells developed later. F. W. R. B.

Thyroid Gland and Growth.—C. B. DAVENPORT and W. W. SWINGLE ("Effects of Operations upon the Thyroid Glands of Female Mice on the Growth of their Offspring," *J. Exp. Zool.*, 1927, 48, 395). Experiments were designed to study the effect of maternal thyroid deficiency on the growth of the foetus and the young animal while suckling. Ablation of the maternal thyroid was performed either by cauterisation or by surgical removal. In the young of thyro-cauterised mothers the death-rate was not appreciably different to that found in control series. Among the thyro-parathyroidectomised mothers the death-rate was exceptionally low. In testing the growth of the young during suckling reciprocal exchange was made between experimental and control mothers in order to neutralise, so far as possible, the effect of variation in the size of litters and the effect of the previous nutrition of the young. The experiments showed that whether nursed by normal or by thyrocauterised females, the control mice grew faster than the mice from experimental mothers. The thyrocauterised mice were poor nurses, and their young had a poor growth capacity. The milk of thyro-parathyrocauterised mothers was normal in amount, but poor in quality, being probably deficient in calcium. The relation of these results to the condition of Mongoloid dwarfing in humans is discussed. A. S. P.

Intersexuality in the Guinea-Pig.—A. LIPSCHUTZ ("On a Peculiar Type of Intersexuality in the Guinea-Pig," *Brit. J. Exp. Biol.*, 1927, 4, 227). An intersexual condition of the external genitalia in 16 otherwise normal female guinea-pigs is described, and it is suggested that the malformation is an instance of partial somatic intersexuality. There was no evidence that the abnormality was of ovarian origin, and four facts definitely suggest the contrary: (a) the ovaries were histologically normal; (b) the ovaries, when grafted into castrated males, produced the typical female hormone effect; (c) ovariectomy of the intersexual female caused no alteration in the intersexual characters; (d) the intersexual horny styles of the clitoris, when amputated, regenerated even after excision of the ovaries, whereas regeneration does not take place in the castrated male. A. S. P.

Cryptorchism.—W. P. KENNEDY ("Unilateral Cryptorchism in a Rat," *J. Anat.*, 1927, 61, 352). A case of unilateral cryptorchism in the rat is described, the right testis being an ectopic, while the left had descended normally. The right inguinal ring contained the vas deferens and blood-vessels, but appeared to be constricted as compared with the left, and the testis, though small, could not be passed through it. No testicular adhesions were found, and the organ was movable. The cause of this abnormality is suggested to be a developmental failure of the organ to pass into the scrotum owing to the constriction of the inguinal ring. A. S. P.

Anterior Pituitary Extract and Gestation.—H. M. TEEL ("The Effects of Injecting Anterior Hypophysial Fluid on the Course of Gestation in the Rat," *Amer. Jour. Phys.*, 1926, 79, 170). The injection of anterior pituitary extract into pregnant rats results in a greatly increased period of gestation and also in the death of term fetuses *in utero*. These results are brought about, firstly, by a delay in the implantation of the embryos, and, secondly, by disturbance of the mechanism of parturition. The injection of anterior pituitary extract causes great development of the ovarian luteal tissue, and since parturition appears to be incited by

the atrophy of the corpora lutea at the end of pregnancy, the failure of the parturition mechanism in injected animals is probably due to the resulting failure of the luteal tissue to atrophy at the normal time.

A. S. P.

Anterior Pituitary Extracts and Placentomata.—H. M. TEEL ("The Effects of Injecting Anterior Hypophysial Fluid on the Production of Placentomata in Rats," *Amer. J. Physiol.*, 1926, 79, 184). In the normal unmated female rat the decidual response to injury of the uterine mucosa is absent. After sterile mating, however, the next oestrous period is postponed and the corpora lutea of ovulation persist for a greater period. During this pseudo-pregnant period the uterine mucosa shows the typical response to injury. It would appear that the corpora lutea are responsible for this increase in the sensitivity of the uterus. It is also found that the daily injection of anterior pituitary extract into the unmated animal brings about the same increased sensitivity of the uterus. Since this effect of anterior pituitary extract is not found in ovariectomised animals, it is clear that the effect is produced through some ovarian activity, and since the injection of anterior pituitary material results in the stimulation of ovarian luteal matter, it seems probable that the anterior pituitary extract operates through the corpus luteum.

A. S. P.

Reproduction in Alcoholic Mice.—E. C. MACDOWELL and E. M. LORD ("Reproduction in Alcoholic Mice; I. Treated Females: A Study of the Influence of Alcohol on Ovarian Activity, Prenatal Mortality and Sex Ratio," *Archiv. für Entwicklung.*, 1927, 109, 549). Experiments were performed on two series of alcoholised mice, one series being subjected to light doses daily, the second series being completely anaesthetised five days a week. The first series, when compared with adequate control material, showed an increased time between mating and parturition, and a greater time before the attainment of puberty. The length of the oestrous cycle, the number of corpora lutea, the size of litter, and the natal and prenatal mortality, showed no change. The second series showed (a) an increased interval between successive births; (b) an increased number of corpora lutea; (c) decreased litter size; (d) an increased number of pregnancies yielding no live young; (e) greater general prenatal mortality. On the other hand, the sex-ratio and the occurrence of abnormalities among the young was not influenced.

A. S. P.

Uterine Grafts.—J. HAMMOND ("Uterine Grafts," *Brit. Jour. Exp. Biol.*, 1927, 4, 349). This paper describes the results obtained by transplanting into the pseudo-pregnant uterus of the rabbit various foetal tissues. It was found that the pseudo-pregnant uterus presented greater opportunities for successful transplantation than the normal uterus. Of the tissues experimented with, large fragments of cartilage and small blocks of epithelial tissue persisted and grew. In the former tissue ossification occurred. In spite, however, of the success of these transplantations, the corpus luteum of pseudo-pregnancy showed no signs of persistence, and the mammary tissue failed to develop beyond the normal pseudo-pregnant state. Hammond suggests that implantation of the embryo is normally brought about by the erosive agency of the foetal trophoblast. In support of this view he brings forward the following experimental facts: (a) grafts placed in connection with the uterine mucosa only were absorbed rather than nourished; (b) the successful foetal grafts were those attached to the muscle layer of the uterus; (c) mechanical irritation of the pseudo-pregnant mucosa results in the formation of deciduomata, but the introduction of living foetal tissue to these failed to result in their further development.

A. S. P.

Growth of the Mouse.—E. C. MACDOWELL, E. ALLEN and C. G. MACDOWELL ("The Prenatal Growth of the Mouse," *J. Gen. Phys.*, 1927, 11, 57). A statistical study of the weight of mouse embryos shows that the general course of prenatal growth in the mouse, the guinea-pig and the chick, can be expressed as a linear relation between the logarithms of weight and age, when the age is counted from the beginning of true embryonic growth. This result is interpreted as showing that the nature of growth in the early embryo is essentially different from that subsequently found. It is suggested that the prenatal growth of a large number of mammals may be accurately compared by using embryo age as opposed to age reckoned from conception or birth. A. S. P.

INVERTEBRATA.

Mollusca.

Les Mollusques post-glaciaires et actuels du bassin de Genève.—J. FAVRE (*Mem. Soc. Phys. et Hist. Nat. Genev.*, 1927, 40, 171–434, 14 pls., 38 text-figs.). This is an exceptionally well-detailed and documented account of the land and freshwater mollusca of the district immediately surrounding the Lake of Geneva. The author has carefully examined all accessible post-glacial deposits as well as the living forms. From these materials he has constructed a faunistic history which is of extreme interest, and has made a series of deductions on œcological and geological grounds as to the changes of climate which have occurred in the district during the last geological age. It has naturally become necessary to define some of the species more definitely than had been done by previous authors, and in the course of this work the treatise approaches the borders of microscopy, though unfortunately no mention is made of radulæ. While he recognises the immense industry of the species-making school of Continental naturalists of the latter half of the nineteenth century, M. Favre himself returns to the older and more practicable view of a species, which certainly harmonises better with his geological findings. The *Limnæas* of the *Gulnaria* group are thus reduced to three, *auricularia*, *ovata*, and *peregra*. *L. auricularia* has a long spermatheca with a duct longer than the organ itself; *L. peregra* has a duct, but it is shorter than the spermatheca; in *L. ovata* the spermatheca is sessile. The extension of the lip of the shell is a character of no importance, but the twist of the columella is a more or less satisfactory character of *L. auricularia*. The observations about the genital organs are due to Roszkowsky (*Rev. suisse Zool.*, 1914, 22, 457–539). Favre has verified them. *L. lagotis* belongs to the *ovata* group. The genus *Valvata* contains two species only, *macrostoma* and *alpestris* being regarded as occasional mutations of *piscinalis*. There are valuable observations about the *Planorbis* and about the allied forms of *Fruticicola* (*hispidus* and *striolatus*). *Bythinella* has been found to be an inhabitant of springs. In the revision of the *Pisidia* the author has been assisted by Stelfox, and the results obtained, when applied to the geological record, tend to confirm his system of specific differentiations. The work is illustrated with very fine plates, six of which are from photographs and bear the classic imprint of Frobenius of Basle. E. W. B.

Fossil Chitons from the Pleistocene of San Quintin Bay, Lower California.—S. S. BERRY (*Amer. Jour. Sci.*, 1926, 12, 455–6). Five species of Polyplacophora are recorded; all species noted are still living on the coast of California or of Lower California or both. Some of the specimens showed a remarkable retention of the original colour pattern. *Biological Abstracts.*

Opercula in Shore Deposits.—H. A. PILSBRY (*Nautilus*, 1926, 40, 69). Cites the finding of numerous opercula of *Bithynia tentaculata* on beaches where none or few of the shells were observed, an occurrence of much interest in connection with the extreme rarity of the shells in the Pliocene deposit carrying *Scalex petrolia*; no explanation has as yet been offered.

Biological Abstracts.

Fossil Viviparus-like Calcareous Opercula.—W. P. WOODRING (*Nautilus*, 1926, 40, 12–14). Fossil calcareous opercula, similar in shape to the horny opercula of living pond snails of the genus *Viviparus*, are more abundant than was supposed. In addition to a Pliocene species from California (*Scalex petrolia* Han. and Gay.), so far known only from cores or cuttings obtained in oil fields they are represented by specimens of supposed Lower Carboniferous age from Nevada (*Ampullaria* ? *powelli* Walcott), and by undescribed material from the Upper Cretaceous Judith River formation and the Eocene Fort Union formation of Montana.

Biological Abstracts.

Anatomy and Function of Genital Apparatus in Limnæa.—E. D. CRABB ("Anatomy and Function of the Reproductive System in the Snail *Limnæa stagnalis appressa* Say," *Biol. Bull.*, 1927, 53, 55–66, 1 pl.). The anatomy is very similar to that of the European *stagnalis* as described by Baudelot. Previous descriptions are summarised. The conclusions reached on the subject of function are referred to in the following paper.

E. W. B.

Fertilisation in Limnæa.—E. D. CRABB ("The Fertilisation Process in the Snail *Limnæa stagnalis appressa* Say," *Biol. Bull.*, 1927, 53, 67–98, 6 pls.). It appears that in this species cross-fertilisation seldom or never occurs, self-fertilisation being the normal method. The ova and spermatozoa are developed simultaneously in a single acinus. Polyspermy occurs before the ovum leaves the acinus. Functional sperms are always present in the hermaphrodite gland and duct in normal healthy adults, "thus by the laws of chance making the competition of foreign sperms unsuccessful." There is no evidence of the desquamation of the lining in any part of the reproductive system, as described in *Helix*. Isolated individuals reproduce as abundantly as those in mass cultures. There is no evidence of gynogenesis or any other form of parthenogenesis. Two polar bodies are extruded in eggs of virgins. (Pelseneer found one only in *auricularia*, *glutinosa* and *palustris*, under similar circumstances.) The haploid number of chromosomes is ten. The author gives a review of recent work on the subject as known to him. He describes in very interesting detail the methods of fixation which he used, and the peculiarities of others which were tried. Lettuce leaf was used for food. The questions of pro-tandry, dedifferentiation, and the various forms of sperms, are dealt with. The illustrations are from drawings.

E. W. B.

Dwarfism in Planorbis.—C. FRANÇA (*Bull. Soc. Portug. Sc. Nat.*, 10, 63–7). This is the first of three papers on Bilharziosis. There are two foci of this disease in Portugal—at Atalaia and at Alportel. In the former locality *Planorbis dufourii* reaches a diameter of only 10 mm. Pallary suggested to the author that this might be due to the warmth of the water (25–5°). They are also less highly coloured, lay fewer eggs, and appear to be debilitated and anæmic. França thinks this due really to the massive infestation with Bilharzia which occurs in this small locality, for which he finds a particular reason.

E. W. B.

Inquillinism of Fish in Mollusc.—E. W. GUDGER ("Aponichthys puncticulatus and *Strombus bituberculatus*," *Zoologica*, 1927, 9, 193–200, 2 figs.). These small fishes live inside the mantle cavity of the snail. The fact was observed by Plate in 1905, the partners concerned being of different species but the same genera.

His observations are quoted *in extenso*. Ginsburg repeated Plate's observation in 1922. The author observed it in the species named above in 1914. He regards it as a one-sided association, of no value to the mollusc. E. W. B.

Glochidium and Juvenile of *Anodonta imbecillis*.—M. E. TUCKER ("Morphology of the Glochidium and Juvenile of the Mussel *Anodonta imbecillis*," *Trans. Am. Micr. Soc.*, 1927, 46, 286-91, 1 pl.). Measurements are given of the size of glochidia and young of the mussel, while the structure of both stages is discussed. G. M. F.

Echinodermata.

Growth of the Sea-Urchin Skeleton.—F. DEUTLER ("Ueber das Wachstum des Seeigelskeletts," *Zool. Jahrb. Abt. Anat. u. Ontogenie*, 1926, 48, 119-200, 7 pls., 22 figs.). The author has re-examined the question of growth in the sea-urchin skeleton by preparing the tests of *Colobocentrotus atratus*, *Echinus esculentus*, and other echini in the following ways. They were cleaned by boiling in eau de Javelle and subsequently embedded in either balsam or colophonium, after which they could be ground and polished. Others were treated with a mixture of terpeneol (22 pts.) and methyl benzoate (1 pt.), which renders the organic interspaces homo-optical with the skeleton, and hence the growth zones can be observed; in *Colobocentrotus* the colouration of these makes the interpretation easier. It was found that growth changes do not always involve all of the plates present, but that each plate has a certain maximum size. When this is attained, growth ceases. In the interambulacral plates, for example, a new period of growth involves a continuous series from the aboral end. One column composed of 26 plates showed the newest growth zone in plates 1-17, the next in plates 2-19, the next in 3-21, the next in 4-22, etc. Beyond the maximum width for the column, the older a plate, the smaller it is. In the aboral zone the opposite is true. New plates in the column arise between the terminal and genital plates. Ambulacral columns also grow by the addition of plates at the aboral end. There is no resorption of the ambulacral plates relative to the interambulacral in the oral region in *Echinus* or *Colobocentrotus*. There are differences in growth between the interambulacral and the ambulacral. The ambulacral plates determine the definitive growth of the shell, while the interambulacral adjust themselves to the imposed conditions. The ambulacral canals are present in the youngest plates, and take their final position in the plate by means of resorption and redeposition of the skeletal material. Beginning with the most adoral plate, on which the oldest growth zone appears, each plate has at some former time been at the aboral end of the column. Growth therefore consists of a mass shifting of the plates in the oral direction. During this apparent migration the younger plates increase in size by the addition of new growth zones, while the older do not. On approaching the oral region, the plates therefore decrease in size. In the immediate border of the peristome the plates are not resorbed in great numbers to compensate for the growth of the columns, but only those the loss of which is necessary for the enlargement of the peristomal opening are eliminated; these are comparatively few. Growth zones may also be found in the spines, the spine tubercles, and the dentary apparatus. Primary, secondary, and tertiary spines may be distinguished according to their size. All skeletal parts seem to grow at the same tempo. The author lists all species examined and notes the presence or absence of growth zones. He considers the pigmentation of the animals due to periodic seasonal vertical migrations which result from changes in environmental conditions; the important factor is light intensity.

Arthropoda.

Arachnida.

Hydracarina of the Douglas Lake Region.—R. MARSHALL (*Trans. Am. Micr. Soc.*, 1927, 46, 268–79, 3 pls.). A study of the water mites of Douglas Lake Michigan yielded 18 genera and 41 species, of which 3 are new. Several species were identified with Old World forms not previously described for America.

G. M. F.

Crustacea.

On the Type of *Gonodactylus spinosus*, a Stomatopod Crustacean. R. P. BIGELOW (*Amer. Nat.*, 1926, 60, 579–82, 2 figs.). A co-type of *G. spinosus* Bigelow was re-examined to determine the identity of this form with *G. demanii* var. *spinosus* Kemp. The uropods of the type bear the complete fringe of setæ characteristic of var. *spinosus*. Additional information as to certain features of head and telson is given and illustrated.

Biological Abstracts.

Additions to Our Knowledge of Symmetrical Pagurids.—J. E. V. BOAS ("Zur Kenntnis symmetrischer Paguriden," *Kgl. Danske Videnskab. Selskab. Biol. Meddelel.*, 1926, 5, 1–52, 25 figs.). Among the symmetrical pagurids or Pylochelinae hitherto described are some taken free, others found in sponges, still others in sunken drift twigs of bamboo and mangrove, or in *Dentalium* shells, but only one in a snail shell, *Xenophora*. Some of these were obviously sitting in a cavity. In some of the house-dwellers it was possible that the occupant could drag his house after him, whereas for others it was impossible, and the crab must leave his dwelling to seek nourishment. This statement is true of the material examined by the present author, who deals with the genera *Mixtopagurus*, *Pylocheles* and *Cheiroplatea*. The Pylochelinae, which are primitive Pagurids, are compared with hermits and with partially symmetrical Pagurine genera. Details of the species are described and figured. *Mixtopagurus longicaulis* (p. 37), *M. brevicaulis* (p. 37), *Pylocheles mortensenii* (p. 40), and *Cheiroplatea laticauda* (p. 44), all from the Kei Islands, are new.

Biological Abstracts.

Additions to Our Knowledge of the Hermit Crab Paguropsis and its Peculiar House.—J. E. V. BOAS ("Zur Kenntnis des Einsiedlerkrebsses Paguropsis und seiner eigenartigen Behausung," *Kgl. Danske Videnskab. Selskab. Biol. Meddelel.*, 1926, 5, 1–23, 11 figs.). Three specimens of *P. typicus* Henderson taken at Kei Islands are thoroughly described. They were dwelling each in a colony of *Epizoanthus paguropsidis* without trace of a snail shell such as is encrusted by the colony of *E. paguriphilus* which houses *Parapagurus pilosimanus*. The Zoanthid also differs from *E. paguriphilus* in its thinner coenarsarc, shorter polyps and absence of sandy incrustation. The method of attachment of the hermit to its polyp colony by its appendages is described and figured. The 3d maxillipede of *Paguropsis* is compared with that of *Eupagurus bernhardus*.

Biological Abstracts.

Researches on Pagurids.—A. BRINKMANN ("Untersuchungen an 'enthäusten' Paguriden," *Bergens Mus. Aarbok Naturv. Raekke*, 1924, 1925, 1926, 1–35, 2 pls., 2 figs.). Results of the examination of 100 individuals, *Eupagurus bernhardus* and *E. pubescens*, all of which were observed through more than one moult and some up to five moults. A special study was made of the structure of the hermit abdomen and its functional mechanism. It was found to be covered with chitin having a certain flexibility due partly to fine wrinkles and to the remains of the original segmentation, and partly to a peculiar muscular arrangement.

The latter enables the enclosed nourishment suddenly to augment and to form very early a considerable mass of eggs. The abdomen adapts itself instantly to the volume of its contents, so that it always appears stuffed. This property of being able to alter the size of the body even without moulting is a mark of superiority of the Pagurids over other Decapods. The inquiry indicates that these house-dwelling hermits show an approach to a condition of non-house-bearing Anomura. They undergo, perhaps, no morphological changes in the abdomen.

Biological Abstracts.

Abnormal Telson in the Amphipod *Bovallia monoculoides* Haswell.—C. CHILTON (*New Zealand Jour. Sci. and Tech.*, 1926, 8, 109–10, 3 figs.). An abnormal, simple undivided telson of a specimen from Western Australia is described, the normal telson being cleft to or beyond the centre; a normal telson and one with one imperfect lobe are also figured. Attention is drawn to the fact that in some cases certain abnormalities would lead to difficulty in the identity of the species, as an undivided telson in *Djerboa furcipes* would make difficult its distinction from *Leptamphopus novæ-zealandiæ*.

Biological Abstracts.

The Nauplius Larva of *Limnetis gouldi*.—R. GURNEY (*Internat. Rev. Ges. Hydrobiol. u. Hydrogr.*, 1926, 16, 114–17, 4 figs.). Determines the situation of the first antenna and the relation of the disc-like expansion of the body of the nauplius of *L. gouldi* to the adult bivalve shell. The antennæ are represented by a small swelling either side of the median eye and bearing a delicate seta. The first antenna of the *Limnetis* nauplius is compared with that of *Bosmina* (*B. longirostris*) and *Bosminopsis* of the Cladocera. The shell valves are visible in the naupliar shield just before the next moult and fill it posteriorly, but are distinct from it and also independent of the anterior fold overhanging the head.

Biological Abstracts.

Iridescent Epithelium and Play of Colours in *Sapphirina*.—W. J. SCHMIDT ("Das Granzepithel und die Schillerfarben der Sapphirinen nebst Bemerkungen über die Erzeugung von Strukturfarben durch Guanin bei anderen Tieren," *Verhandl. Naturhist. Ver. Preuss. Rheinl. u. Westfal.*, 1925, 1926, 82, 227–300, 11 figs.). Observations were made on *S. ovatolanceolata* Dana and *S. darwinii* Haeckel (= *aureofurca* Giesbrecht). Construction of the epithelium, constancy of its cells, refraction and chemical nature of the iridescent plates, origin of the play of colours, and effects produced by certain reagents and by death are described. Iridescence of *Sapphirina* is compared with that of butterflies and birds. Production of colour by guanin in other animals, especially the fish *Argyrops leucurus*, is discussed.

Biological Abstracts.

On *Cyclops americanus* Marsh.—A. G. LOWNDES (*Ann. and Mag. Nat. Hist.*, 1926, 17, 616–19, 2 figs.). This species is recorded in the British Isles for the first time; the chief difference between it and *C. lucidulus* Koch lies in the shape of the seminal receptacle, both of which are figured. Spine formula is not a specific characteristic for this species.

Biological Abstracts.

Insecta.

Sexual Selection and Allied Problems in the Insects.—O. W. RICHARDS (*Biol. Reviews*, 1927, 2, 298–364). An exhaustive review, with a bibliography containing references to 406 papers.

G. M. F.

Oviposition of the Egyptian Grasshopper.—S. M. FEDOROV ("Studies in the Copulation and Oviposition of *Anacridium aegyptium* L. (Orthoptera, Acrididae)," *Trans. Ento. Soc. Lond.*, 1927, 75, Pt. I, 53–61, 4 pls.). A description of the intimate processes of the sexual life of the Egyptian grasshopper is given, as a preliminary communication on the results of the studies of the author and his associates on the general bionomics of this insect both in nature, under the conditions of the south coast of the Crimea, and in the laboratory. Fertilisation of the female is produced by the prolonged copulation of the two sexes, during which sperm is transferred to the female by the agency of spermatophores. The number of spermatophores transferred depends upon the length of the copulation period. From 6 to 30 empty spermatophores were found between the female ovipositor valves in copulation periods of from 18 to 60 hours. The author states that from an hour and a half to two hours are necessary for the formation of a spermatophore and its transfer from the male to the female. This, in part, explains the prolonged copulation period. On the matter of oviposition, the author states that the hole in the ground for the egg-pod is dug by the upper and lower pairs of valves of the ovipositor. The extension of the abdomen is due mainly to extension of the membranes between the 4th to 5th, 5th to 6th, and 6th to 7th segments. The air-sacs during the expansion of the abdomen are strongly inflated, the air being pumped into them through the abdominal stigmata by rhythmic movements of the abdomen. Air is also swallowed by the insect, and serves mainly for expanding the alimentary tract in accordance with the extension of the abdomen. The eggs are always in an envelope of foamy material, preserving them from external influences. Eggs in the egg-pod are always placed with their micropylar ends downwards.

M. E. M.

South African Species of Weevils.—GUY A. K. MARSHALL ("On the South African Species of *Nanophyes* (Col. Curculionidae) and Some Allied Genera," *Trans. Ento. Soc., Lond.*, 1927, 75, 79–98, 1 pl. and 3 text-figs.). Up to the present time only four species of *Nanophyes* Schh., 1838, have been recorded from South Africa, but the author considers this fact arises almost entirely from neglect of these small weevils by the earlier collectors. A key to the genera of the *Nanophyinae* known to the author is given, and the main work is devoted to a description of species (many of which are new) from different parts of South Africa.

M. E. M.

Diploid Males in Habrobracon.—A. R. WHITING ("Genetic Evidence for Diploid Males in Habrobracon," *Bio. Bull.*, 1927, 53, 438–49). Four allelomorphs affecting eye colour and three pairs of allelomorphs affecting wing form and venation, none linked, are studied from the point of view of the method of their inheritance by biparental males in *Habrobracon juglandis* Ashmead. A female homozygous for one or more recessive factors when crossed to a male carrying allelomorphs to these factors produces, in addition to recessive haploid sons and dominant diploid daughters, sons which have all dominant characters like their sisters. In crosses where females are homozygous for some recessive and some dominant factors and males possess allelomorphs, the biparental sons are entirely dominant, showing that they have some factors from each parent. When three of these factors affect one structure, if one is recessive and two dominants are contributed by one parent, their allelomorphs by the other, this structure in biparental males shows all the dominant characters. It is therefore concluded that biparental males are diploid at least for the four chromosomes that can be identified genetically. Biparental males and their daughters are often abnormal in appearance and usually sterile. When fertile they breed as dominants.

G. M. F.

A Bristle in *Drosophila*.—R. L. KING ("Origin and Description of Bristle in *Drosophila melanogaster*," *Biol. Bull.*, 1927, 53, 465-68). A new bristle form in *Drosophila melanogaster* is described, named Bristle B1. The mutant gene is a dominant, lethal when homozygous. The locus of B1 lies 0.18 p.c. to the right of purple at approximately 54.8 in the second linkage group. A stock of Bristle lobe balanced against Curly has been made up and is available for use. G. M. F.

A Bee's Nest in a Glass Tube.—E. MAY ("Ein Bienennest in einem Reagenzglas," *Natur und Museum*, 1927, 57, 209-14, 7 text-figs.). A glass tube which had been used for wireless telegraphy purposes was found to be blocked when an attempt was made to pass a wire through it. Examination showed that one of the solitary bees of the genus *Osmia* had adopted the tube as a nesting-place. The tube was sent by Herrn. R. Kurth, of Frankfurt, to the author for examination. The tube was found to contain nine separate cells, in eight of which were eggs and a larval food-supply. Fabre's experiments with bees of this genus nesting in glass tubes is discussed and recounted, and the author describes the experiments he has under way in connection with further studies. A study of the internal anatomy of the larvæ has shown that, contrary to the accepted belief, the complete alimentary canal is functional shortly after the emergence of the larvæ from the eggs. Information is given in regard to the parasites of the *Osmia* bees, and the interesting formation by the mother-bee of an unoccupied cell at the end of the nest, to safeguard her progeny from the attentions of the *Ichneumonidæ*, is described. M. E. M.

Butterflies of Brisbane.—R. ILLIDGE ("Brisbane Butterflies of the Family Papilionidæ, Series II," *The Queensland Naturalist*, 1927, 6, 47-51, 1 pl.). *Papilio sarpedon choredon* Felder. This wide-ranging butterfly is found from New South Wales as far north as Japan, with a wide westerly expansion through the Malay Archipelago and Peninsula to North India. The Brisbane form differs but little from the Indian. Its earliest appearance on the wing is in September, and from that time onwards, to the end of April, it is more or less abundant. Being an active creature, it is not easily captured, but they are easy to obtain after sunset in the gardens when they take up their positions for rest during the night. Specimens bred from caterpillars found on the camphor laurel are said rarely to attain the rich hues of the insects born in the sunshine. The original native food-plant of this butterfly is very obscure, as the camphor laurel is an introduced plant. *Papilio eurypylus lycaon* Westwood is equally abundant in Brisbane. The larvæ feed on various anonaceous plants, and have already taken largely to the introduced custard apple. An ochreous-yellow form of this species is occasionally encountered. *Papilio macleayanus* Leach is confined to Eastern Australia and Tasmania, and is not by any means a common butterfly in the vicinity of Brisbane. It is, however, often taken at Bulimba about the camphor laurels. The blossoms of the orange and other sweet-scented flowers are very attractive to it, but the larvæ, as far as the author knows, have not been found either on the orange or lemon. *Papilio leosthenes* Doubleday, like the preceding species, is an Australian form, but has a restricted range from Richmond River to Cape York. Its larvæ are found on the *Melodorum leichhardtii*, and it is fairly common around Brisbane. M. E. M.

Pharyngeal Glands of the Honeybee.—PH. DR. ŠT. SOUDEK ("Hltanové žlázy včely Medonosné (*Apis mellifica* L.), The Pharyngeal Glands of the Honeybee (*Apis mellifica* L.," *Sborník Vysoké Školy Zemědělské v Brně, ČSR, Fakulta Hospo-*

dárská, 1927, Sign. C 10, 3 pls., 15 text-figs.). The paper is a record of interesting microscopical and cytological investigations of the pharyngeal glands. The author has traced the histological development of the glands, and finds it does not coincide with previous conceptions. A full description of the anatomy of these glands is given, and their development is stated to begin in the late pupal stage about the time when the compound eyes turn reddish. The glands themselves seem to have their origin in the material stored in the cells of the fat-body. A study was made of the condition of the glands of bee-workers in different activities, which supported the well-known observation that there is a constant relation between the physiological state of the pharyngeal glands and the activities of the bees. The largest developments of actively secreting glands were in bees collected from the brood-combs, while the empty and atrophic glands were found in the pollen, nectar, and water collecting bees. In order to get an insight into the possible action of different foods on gland development, laboratory feeding experiments with newly-hatched bees were undertaken. On a diet of pure sugar syrup and pure honey given to very young bees whose pharyngeal glands were not yet active, it was found that the glands did not develop, and from 5 to 25 days later that the glands were even smaller than they were at first. On a diet of sugar syrup mixed with pollen, honey mixed with pollen, and pollen only mixed with water, the pharyngeal glands were found to develop conspicuously, particularly when the diet consisted of pure pollen or pollen and sugar. The author therefore concludes that the glands only develop under the stimulus of the protein content of the pollen-grains, but it was observed in these experiments that the development of the glands was neither so marked nor so rapid as was the case with the bees in the hive. Experiments were undertaken with pollen substitutes, but development of the glands failed to occur. From the results of his work and other observations the author concludes that one function of the pharyngeal glands is the production of the brood-food.

M. E. M.

Sheep Maggot Flies in France.—L. MERCIER, "Présence de *Chrysomyia albiceps* Wied. (Mouche du Ver, épineaux de la laine des moutons australiens) sur la Côte du Calvados," *Compt. Rend. de l'Acad. de Sci.*, 1927, 185, 16). After a short account of the characters of *Chrysomyia albiceps*, the author states that this fly has a wide geographical distribution, that it is widely spread in the Mediterranean region, on the continent of Africa, in India, and in Australia. It has been recorded from Spain and Egypt, and closely related species occur in the New World. In France *C. albiceps* occurs all along the Mediterranean coast, the most northern limit being represented so far by a capture made by Rabaud in 1908 in the region of Saint-Affrique (Aveyron). During the last two years, however, the author has been able to prove that this species is to be found much farther north. For example, in September, 1926, he captured a female specimen of *C. albiceps* on the windows of the marine laboratory at Luc-sur-Mer, and during September, 1927, he caught two males that were flying over the surface of refuse situated in an outhouse of the laboratory. The presence of *C. albiceps* in this locality presents a biogeographical problem. Either the larvæ or pupæ have been transported in the hides imported from Australia and Africa, and have emerged as adults in the warehouses, from which they have dispersed along the coasts, helped by the winds, or *C. albiceps* forms part of the southern indigenous fauna. Whichever is the case, however, the author thinks, taking into account the fact that this insect is so rarely encountered, that there is no reason to fear *C. albiceps* becoming a danger to indigenous hides.

M. E. M.

Structure of Insect Gills.—P. PERFILJEV ("Über den Kiemenbau einiger Insektenlarven (Structure of the Gills in Certain Insect Larvæ)," *Bull. de l'Acad. des Sci. de l'U.R.S.S.*, 1926, 6, 1599-1617, 1 pl.). Previous investigations on this subject have dealt mainly with the external form of the gills and to some extent with their physiological function, the details of the construction being dismissed very briefly. The author here gives the results of his own observations, noting, in passing, points already mentioned in the literature. The material consisted of the larvæ of *Paraponyx*, *Sialis*, *Clæon*, *Molanna*, *Phryganea*, *Agrion* and *Gyrinus*, collected during the second half of the summer and autumn from ponds in the parks of Pavlovsk and Djetskoje Sjelo, and of *Calopteryx* and *Hydropsyche* from the Ugljanka River, Novgorod. The specimens were fixed in Dubosq-Leeuwen mixture, the small larvæ remaining unopened and being cut into serial sections, while the larger ones, such as *Phryganea*, were previously opened in saline solution and only the skin with the gills fixed. After dehydration in the ordinary way some specimens were embedded in paraffin and other in celloidin. Sections from the latter gave a clearer picture of the structure, while the former showed the topographical picture especially well. In most cases the sections were stained with Giemsa, Heidenhain's iron-hæmatoxylin, Mallory's hæmatoxylin-eosin, and Unna's polychrome methylene-blue. The examination showed the gills to fall externally into two groups, the filiform and lamellate, the internal structure being in complete harmony with this grouping. To the first group belong the gills of *Paraponyx*, the *Trichoptera* and *Sialis*. These show a simple structure, those of *Paraponyx* and the caddis flies being more primitive in arrangement than those of *Sialis*, which have muscle fibres in the gills themselves. To the second group belong the *Clæon* and the *Libellulidæ* larvæ. The gills of the *Agrionidæ* are the most complicated, their characteristic features being the universally branching type of the trachæ, the presence of transverse muscular fasciculi, and the isolation of the branchial cavity which is indicated as a blood sinus. In the base of the gill a septum is present which separates the branchial cavity from the body cavity. The gills of *Gyrinus* occupy an intermediate position. Though filiform in shape, they exhibit features which bring them into relation with the lamellate group, i.e. the presence of a septum in the gills of the last segment and the branching type of the trachæ in all the gills. A peculiarity is the presence of Stein's glands in the gills of the ninth segment.

M. E. M.

Ants from Costa Rica.—CARLO MENOZZI ("Formiche raccolte dal Sig. H. Schmidt nei dintorni di San José di Costa Rica (Ants collected by Mr. H. Schmidt in the Region of San José, Costa Rica), Conclusion," *Entomologische Mitteilungen*, 1927, 16, 336-45, 12 text-figs.). The following species are described: *Cryptocerus maculatus* F.; *Azteca pittieri* Forel; *Myrmelachista plebecula* n. sp.; *Brachymyrmex santschii* n. sp.; *Camponotus* (*Myrmotherix*) *abdominalis* var. *costaricensis* Forel.; *Camponotus* (*Pseudocolobopsis*) *orthocephalus* Emery; *Camponotus* (*Myrmobrachys*) *striatus* F. Sm.; *Camponotus* (*Myrmobrachys*) *dolabratus* n. sp. The author adds biological notes on certain of the ants in Schmidt's collection, a large number of which are tree-inhabiting species.

M. E. M.

Insect Fauna of the Balearic Isles.—H. EIDMANN ("Zur Kenntnis der Insektenfauna der balearischen Inseln (Insect Fauna of the Balearic Isles)," *Entomologische Mitteilungen*, 1927, 16, 24). The author states that his principal interest lay in biological problems concerning ants. His collections of ants from these islands have already been described by C. Menozzi in the *Zoologischer*

Anzeiger, 1926, vol. 66, and by the author himself in the *Zeitschrift für Morphologie und Ökologie de Tiere*, 1926, vol. 6, while C. F. Frings has described the *Lepidoptera* collected in the *Entomologische Rundschau*, vol. 43. The insect fauna of Majorca is remarkable for the great preponderance of xerophile forms, owing probably to ecological conditions. This was noticeable, not only among the *Formicidæ*, but was commented upon by Frings, who noticed the surprising smallness of many of the *Lepidoptera* as compared with those from other localities, which, he suggested, indicated a rapid development in a hot, arid region where the caterpillars were nourished on food deficient in sap. At the same time there exist regions rich in vegetation and even of a marshy character where the moisture-loving creatures find conditions satisfactory to their existence, so that some knowledge of the soil and climate is required if the fauna are to be understood. Evidently much interesting work awaits the naturalist in this island group. A full list of the collected insects is given, and specimens believed to be new are marked with an asterisk.

M. E. M.

Australian Mosquitoes.—I. M. MACKERRAS ("Notes on Australian Mosquitoes (*Diptera*, *Culicidæ*), Part I—The Anophelini of the Mainland," *Proc. Linn. Soc. of N.S.W.*, 1927, 52, No. 211, 33–41, 3 text-figs.). The author extends the work of Hill (1925), special attention being paid to the males and larvæ. The status of the various forms of *A. annulipes* Walk. are discussed, and the opinion expressed by Hill and Ferguson, as to the synonymy of *A. mastersi* Sk. with this form, is confirmed. Keys are given to the females and larvæ of all the species occurring on the mainland, and figures of, and notes on, the male hypopygia. The life-histories of *A. atratipes* Sk. and *A. stigmaticus* and the larva of *A. amictus* Edw. are described for the first time. The keys deal with the following species: *A. punctulatus* Don., *A. annulipes* Walk., *A. amictus* Edw., *A. stigmaticus* Sk., *A. bancrofti* Giles, and *A. atratipes* Sk.

M. E. M.

Australian Diptera.—J. R. MALLOCH ("Notes on Australian Diptera, No. X," *Proc. Linn. Soc. of N.S.W.*, 1927, 52, 1–16, 12 text-figs.). The author presents a revised synoptic key to the species of the genus *Drosophila* Fallén, with descriptions of some new species, a synopsis of the species of the genus *Homoneura* van der Wulp, descriptions and records of the genus *Sapromyza* Fallén, and descriptions of some other acalyptrate *Diptera*, most of which had been received from Dr. E. W. Ferguson.

M. E. M.

Wing Field of Nematocerous Diptera.—CHARLES P. ALEXANDER "The Interpretation of the Radial Field of the Wing in the Nematocerous Diptera, with Special Reference to the Tipulidæ," *Proc. Linn. Soc. of N.S.W.*, 1927, 52, 42–72, 92 text-figs.). In the course of his studies on the *Tipulidæ* the author has long felt dissatisfied with the interpretation hitherto adopted in regard to the adial field of the wing in *Diptera* (Needham, 1908; Comstock, 1918, 1924; Tillyard, 1919; MacGillivray, 1923). At first sight this interpretation would suggest a double dichotomy of the branches of the radial sector, as in the hypothetical type of insects, and this is considered true in the two most generalised families of living *Diptera* (*Tanyderidæ* and *Psychodidæ*). In all higher *Diptera*, however, one or more branches of this dichotomy have been lost, and this has been interpreted as having been brought about by a fusion to the margin of either the upper fork (*Ptychopteridæ*, *Brachycera*) or the lower fork (*Nematocera*) of the primitive dichotomous sector. In the present paper the author has attempted to demonstrate that the true radial cross-vein (*r* of Comstock and Needham;

*ir*₁ of Tillyard) has never been developed as a *transverse* element in the *Diptera*, as shown by all the above students, and should be omitted as such from any archetype of the order. The vein lies as a *longitudinal* element in a serial alignment, distinct as a separate unit only in the sub-families *Architipulinae*, *Tipulinae*, and *Cylindrotominae*, and two tribes of the *Limoniinae*, the *Lechiini*, and some *Limoniini*. A special effort has been made to choose representatives of the Australian genera where these showed the points involved. The critical review here presented leaves the author convinced that the main principles as given at this time are correct.

M. E. M.

Gall-Forming Thrips.—DUDLEY MOULTON ("New Gall-forming *Thysanoptera* of Australia," *Proc. Linn. Soc. of N.S.W.*, 1927, 52, 153–60, 1 pl. and 14 text-figs.). The gall-forming thrips of Australia include many of the most interesting forms of the Thysanoptera. The author describes the following species:—*Kladothrips augonsaxos* n. sp.; *K. rugosus* Froggatt; *Choleothrips geijerae* n. sp.; *Dolerothrips* (?) *geleræ* n. sp.; *Eothrips bursarica* n. sp., and mentions their host plants and habitats.

M. E. M.

A South African Scale Parasite.—HARRY S. SMITH and HAROLD COMPERE ("The Establishment in California of *Coccophagus modestus* Silv. (*Aphelinidae*, *Hymenoptera*), with Notes on its Life-History," *University of California Publications in Entomology*, 1927, 4, 51–61, 2 text-figs.). The paper is an account of the successful establishment of *Coccophagus modestus* Silv., introduced into California from South Africa, with notes on its life-history and descriptions of its stages. This is a primary parasite of the black scale, *Saissetia oleæ* Bernard. It is credited with being one of the most effective of an aggregation of species which control the black scale in South Africa. After many unsuccessful attempts the authors succeeded in 1924 in establishing the parasite in Southern California. Females show a marked predilection for third stage scale, the so-called "rubber-sized" individuals. The eggs are deposited through the mid-dorsal regions of the scale, and the egg floats in the fluid contents of the host. The newly-hatched larva is about 0.6 mm. in length, is actively motile, and when fully grown measures about 1.3 mm. Parasitised scales may live and produce eggs, but in the majority of cases parasitised scales do not produce eggs, although they live until the emergence of the parasite. In some cases more than one egg is deposited in a single host, and two or more larvæ of the parasite will begin their development together. If this happens, the larvæ are thought to engage in combat at their first encounter, and only one survives. In other cases, when the first inhabitant of the host is partially developed, it receives an egg intended for the scale. In most of the observed cases of this superparasitism the first inhabitant had commenced to pupate before being overcome, and the superparasitic larva transformed within the puparium of the accidental victim.

M. E. M.

Insect Fertilisation of the Orchid.—Abstract from the *Proc. Ento. Soc., Lond.*, 1927, 2, 31–32). The work reviewed is that of Monsieur M. POUYANNE, Conseiller à la Cour d'Appel, Alger, on the fertilisation of three Algerian orchids—*Ophrys speculum* Link, *O. lutea* Cav., and *O. fusca* Link. The most essential element in this discovery was the fact that the fertilising insects are the males of certain burrowing *Aculeates*, which, emerging from the earth several days or even weeks before the females, continue to haunt the locality on the look-out for the first appearance of the latter sex. During this period they are irresistibly attracted by anything which bears even a rough resemblance to the female. The flowers of the

three species of *Ophrys*, which commonly grow near the colonies of the burrowers, open at this critical period in the life of the males and present a superficial likeness to the females or to some characteristic feature of them. These flowers are eagerly sought by the males, and they will seek and settle on those of *O. speculum* even when picked and held in the hand. The attraction is entirely sexual, the flowers do not produce insect food, and the visiting males do not seek it, but are entirely engrossed in the actions called forth by the sexual stimulus. Usually the flowers which open first are chiefly sought and more frequently fertilised, while the last are often neglected.

M. E. M.

Butterfly Migration.—C. B. WILLIAMS ("A Study of Butterfly Migration in South India and Ceylon, based largely on Records by Messrs. Evershed, E. E. Green, J. C. F. Fryer and W. Ormiston," *Trans. Ento. Soc., Lond.*, 1927, 75, 1-33, 10 text-figs.). The author has undertaken a survey of all the known information about unidirectional flights or "migrations" of butterflies in the extreme south of India and Ceylon. At Kodailanal the records show a regular flight of about 21 species of *Papilionidæ*, *Pieridæ*, *Danaidæ*, and *Nymphalidæ* towards the south, starting occasionally as early as the end of August or September, but usually at its maximum in October and ceasing about mid-November, and a northerly flight of *Pieridæ* only in February to March and also in May and June. A *Lycænid* has also been recorded migrating south-east in January, February and March in two years. The November flight is about the beginning of the north-east monsoon, the February to March flight is just after the middle of this monsoon period, and the May to June flights about the beginning of the south-west monsoon. In Ceylon about 69 out of a total of 234 species known in the island have been recorded as taking part in the flights. The direction of the flights are different in different parts of the island. There are many exceptional flights which do not fit into a general scheme. The times of flight seem to bear some correlation with the changes of the monsoon seasons, but what this is is not clear. It has been suggested that the flights originate owing to drying up of food-plants, but this also appears to be doubtful. The general opinion is that the majority of the Ceylon flights originate in the northern half of the island, which is also the driest. There is little direct evidence of direct flights between India and Ceylon, but it is interesting to note that only three out of the 69 species recorded migrating are species peculiar to Ceylon, while 35 of the 167 non-migrants are peculiar. This appears to be direct evidence of the greater isolation of the non-migratory species. The author concludes that further information is needed on every point before reliable deductions can be drawn.

M. E. M.

An Aquatic Lampyrid Larva.—K. G. BLAIR ("An Aquatic Lampyrid Larva from South Celebes," *Trans. Ento. Soc., Lond.*, 1927, 75, 43-45, 1 text-fig.). The single larva forming the subject of this paper was collected by Dr. Malcolm A. Smith at Djikoro, Bothain, South Celebes, in February, 1925, in a mountain stream at an elevation of about 4,000 feet. Four or five of them were seen, the points of light being visible on the stones at the bottom of about two feet depth of water. Two were secured and one was lost. In appearance the larvæ are said to be very much like those of partly-grown larvæ of *Lampyris*, and a figure in the text illustrates this fact. The author compares this larva with the larvæ of other aquatic species of *Lampyridæ*, and concludes, as regards the South Celebes specimen, that it is at present impossible to assign it with certainty to any genus. It is said to present certain features which resemble *Colophotia brevis*, of which the author appends a description.

M. E. M.

Life-History of *Coccinella*.—O. A. MERRIT HAWKES and T. F. MARRINER ("A Preliminary Account of the Life-History of *Coccinella* II—*punctata* L.," *Trans. Ento. Soc., Lond.*, 1927, 75, 47-52, 4 pls., 2 text-figs.). The authors describe the life-history of this ladybird. The insect was first described by Linnæus in 1758, and although it has been studied by many collectors on account of its numerous aberrations, its life-history until now has remained unknown. Large numbers of this ladybird were found on Burgh Sands in August, 1926. Burgh Sands are flat meadows to the south of the Solway Firth, three and a half miles to the north-west of Carlisle. Numbers of the insects were seen running about on dung-pads. Just inside the holes, many of which were made early in the history of the dung-pads by escaping gases, empty pupa-cases were found which were so fresh and unshrunk that the ladybirds had evidently just left them. Larvæ, all in the last instar, were found either walking on the dung-pad or just inside the holes. No last instar larvæ were found deep in the pad, but considerable numbers of eggs were discovered attached to the top of the passages. The authors describe the eggs, larvæ, pupæ and imagoes, and also give a short account of the natural enemies of this insect. M. E. M.

Nemathelminthes.

Nematoda.

The Nervous System of Pelagic Nemertean.—W. R. COE (*Biol. Bull.*, 1927, 53, 123-38, 11 text-figs.). In bathypelagic nemerteans (Pelagica) the nervous system differs considerably from that found in the littoral and bottom living relatives (Reptantia). The special sense-organs of Reptantia are either entirely lacking or are merely vestigial in the bathypelagic forms. In a recently described species, *Neuronemertes aurantiaca*, the dorsal nerve is not connected directly with the brain, but is provided with metameric ganglia not previously known for any nemertean. A pair of dorsolateral nerves connects both with the dorsal nerve and with dorsal peripheral branches of the lateral nerve cords. A delicate intermuscular plexus lies between the two body musculatures. G. M. F.

The Report of a Nearly Pure *Ancylostoma Duodenale* Infestation in Native South American Indians and a Discussion of its Ethnological Significance.—F. L. SOPER (*Amer. Jour. Hyg.*, 1927, 7, 174-84). This paper contains data on the species infestation of Lengua Indians living in the Gran Chaco Paraguayo, together with a discussion of the possible origin of the Amerind race. Worm counts were made on 71 previously untreated Indians at Makthlawaiia, after a treatment with 3 cc. of oil of chenopodium, or with 3-5 cc. of a two by one mixture of carbon-tetrachloride and oil of chenopodium. Of 3,217 hookworms recovered, 228 (7 p.c.) were necator, and 2,989 (93 p.c.) were ancylostoma. This 13 : 1 ratio is the highest reported in America. The various data obtained were interpreted to indicate as follows: that ancylostoma duodenale came to the Chaco with the Indian tribes, while necator is only now being introduced from outside contacts; that the original Amerind stock originated in Asia or Indonesia north of lat. 20 N., and migrated to America via the Pacific or by the Bering Straits—if by the latter at a period when special conditions (either climatic or of rapidity of migration) must have obtained. J. L.

Helminthiasis and the Thyroid Gland.—J. E. ACKERT and G. F. OTTO (*Amer. Jour. Trop. Med.*, 1927, 7, 339-47, 1 text-fig.). In order to investigate the nature of the possible connection between helminthiasis and a pathological thyroid, the authors examined the thyroids of 13 chicks of the same age. One half of these

were fed with 300 eggs each of *Ascaridia lineata*, the other half being kept as controls. After three weeks of this parasitism, there was no significant difference in the size of the thyroid, and no histological changes were observed. J. L.

Human Ascaris as a Household Infection.—H. W. BROWN (*Jour. Parasitol.*, 1927, 13, 206–12). The author records the results of an investigation into the etiology of *Ascaris* infestation in certain regions of Panama, where 40–90 p.c. of the population are infected, and yet human excrement is not used as a fertiliser, and water pollution is rare. The soil sweepings of dooryards and hut floors were found to contain *Ascaris* eggs in all stages of development, and the investigations showed that such floor soil was the most important source of infection in these areas. J. L.

Preliminary Note on the Anthelmintic Value of Tetrachlorethylene based on Egg Counts before and after One Treatment.—L. SCHAPIRO and N. R. STOLL (*Amer. Jour. Trop. Med.*, 1927, 7, 193–98). Tetrachlorethylene was tested for its value under field conditions, and the patients received no special preparation, but were ordered to take a light meal the evening before and no breakfast on the day of treatment. The purge used was $MgSO_4$ (1 oz. in 40 cc. of water), the adult dose being $1\frac{1}{2}$ –2 oz. The drug was easily taken and was administered simultaneously with the purge, and was followed by 4–8 oz. of sugar water in the same glass, which, being mixed with the dregs of the drug, ensured that the full dose was received. In the test treatment of 14 hookworm patients there was a reduction in egg output of 93 p.c. with 3 cc. and 88 p.c. with 2 cc. of the drug. Under field conditions the same doses gave a reduction of 81 p.c. and 77 p.c. respectively. This smaller reduction was probably due to the less preliminary preparation and control of the field cases, and to the figures being based on only one count before and after treatment. It was found that fractional doses were less effective. While tetrachlorethylene gave no reduction in the egg count of *Ascaris*, it was found to be slightly more effective than oil of chenopodium with *Trichiuris*. J. L.

The Relative Egg-Laying Function of *Necator Americanus* and *Ancylostoma duodenale*.—F. L. SOPER (*Amer. Jour. Hyg.*, 1927, 7, 542–60, 6 text-figs.). The author gives worm count data from four Paraguayan hookworm cases of which the egg counts for from 9 to 30 days each had been recorded previously. He applies the method of least squares to the correlation of egg output with the species distribution of the worms in each case. A complementary study of the numbers of eggs found in the bodies of *Ancylostoma duodenale* and *Necator americanus* is also given. From these two sets of data he finds that the average egg-per-day output of the female *Ancylostoma* is two to two and a half times that of the female *Necator*. There was a considerable variation in the numbers of eggs in females of the same species not highly correlated with variation in length. It was found that the anthelmintic may influence the egg counts, especially those of *Ancylostoma*, and it is suggested that the variation of egg counts within the species may reflect either an irregularity in egg-laying or a cycle in the production of egg cells. J. L.

Platyhelminthes.

Trematoda.

Adult Distomes in a Sagitta.—E. LINTON (*Trans. Amer. Micr. Soc.*, 1927, 46, 212–13, 2 text-figs.). Two appendiculate distomes were found in the alimentary canal. Each was a little over a millimetre in length. These distomes

were distinct from the two species previously recorded from *Sagitta*, and are considered by the author to resemble most nearly *Hemiurus crenatus* (Rud.) Luhe, (*Distomum ocreatum* Molin). J. L.

Studies on the Trematode Family Strigeidae (Holostomidae) No. 6. A New Metacercaria Neascus ambloplitis, sp. nov. representing a new Larval Group.—R. CHESTER HUGHES (*Trans. Amer. Micr. Soc.*, 1927, 46, 248–267, 2 pls.). The author describes a new species from the myotomes and integument of *Ambloplites rupestris* (Rafinesque), taken from Douglas Lake, Michigan. Of the 29 specimens examined, 25 were found to be infected. The cysts numbered 4–200 per specimen. The so-called “reserve excretory bladder” of this metacercaria is very well developed and is described and discussed in detail. A new larval group *Neascus* (“new bladder”) is defined, in which it is proposed that the new species and *Diplostomum cuticula* should be placed. The author suggests that a study of the origin and development of the reserve excretory bladder would be of value in taxonomic and life-history investigations. J. L.

Revue of the genus *Spiroorchis* MacCallum.—G. A. MACCALLUM (*Ann. Parasitol. Hum. et Compar.*, 1926, 4, 97–103, 5 figs.). Flukes of the genus *Spiroorchis* (Spororchidae) found in turtles live, like the Schistosomidae of man, in the circulatory system and deposit their eggs in the tissues of their host. The five species here considered include *S. pictæ* (p. 100) from *Chrysemis pictæ*, *S. chelydræ* (p. 101) from *Chelydra serpentina*, and *S. blandingi* (p. 102) from *Emys blandingii*. *Biological Abstracts*.

Life-Cycle of a Trematode of the Echinostomidae.—P. MATHIAS (“Sur le cycle évolutif d'un trématode de la famille des Echinostomidae Dietz (*Echino. paryphium recurvatum* Linstow,” *Compt. Rend. Acad. Sci., Paris*, 1926, 183, 90–2). *Planorbis planorbis* L., from the marshes at Saint-Jean-de Losne (Gold Coast) were found infected with rediæ. The cercariæ developed within the rediæ are provided with a collar of hooklets and after emerging from the snail re-enter other molluscs. The “livers” of *P. planorbis* containing the encysted cercariæ were fed to uninfected ducks, in the excrement of which eggs appeared seven to eight days later. The adult flukes found in the small intestine are identified as *E. recurvatum*. The life-cycle was also demonstrated experimentally in another variety of duck (*le canard mignon*) and in *Munia atricapilla* Vieillot. The author also comments briefly on the excretory system of the miracidium. *Biological Abstracts*.

Cestoda.

Notes on Cestodes Parasites of Birds.—E. LINTON (*Proc. U.S. National Mus.*, 1927, 70, 1–73, 15 pls.). These notes were made on the material collected by the late Vinal N. Edwards in the Woods Hole region, Massachusetts. Examination of the fish-eating birds had not, as had been hoped, revealed any stages in the life-history of the helminths common to birds and fish. Before going on to describe the species of the collection, the author gives a list of the food of the bird hosts, with a view to their suggesting lines of inquiry with regard to the life-histories of the cestode parasites. A full description of each of the 34 species is given, together with notes of its collection, and they are well illustrated in the 15 plates which follow. J. L.

Two New Species of the Cestode genus *Mesocoestoides*.—J. F. MUELLER (*Trans. Am. Micr. Soc.*, 1927, 46, 294). Two new species, *M. latus*, parasitic in

Mephitis minnesotæ, and *M. variabilis*, parasitic in *Urocyon cinereoargenteus californicus*, *Spilogale phenax phenax*, and *Mephitis occidentalis occidentalis*, are described from America.

G. M. F.

Cœlenterata.

Hydrozoa.

Localisation of New Axes in Corymorpha.—C. M. CHILD ("Experimental Localisation of New Axes in *Corymorpha* without Obliteration of the Original Polarity," *Biol. Bull.*, 1927, 53, 469–80, 18 text-figs.). Buds have never been seen to arise from lateral stem regions in *Corymorpha*, and a simple transverse cut into the side of the stem closes rapidly without development of a bud or other outgrowth, unless it extends almost through the stem. A region of injury produced on the side of the stem by short cuts radiating from a centre closes less rapidly than the simple transverse cut, and in many cases gives rise after closure to a rounded outgrowth, which becomes conical and develops a stem at the expense of the old stem, and in some cases the new axis determines a new basal end on the opposite side of the piece, thus completing a polarity at right angles to the original axis. Occasionally two hydrants instead of one are localised by the injury. The experimental data indicate that the new polarity and symmetry are the necessary consequences of a centre of cellular activity. The radial gradient of decreasing activity from the centre peripherally becomes, as growth proceeds, the axial gradient, and the radial symmetry is primarily merely a similarity of all radii vertical to the polar axis at any level.

G. M. F.

Asexual Reproduction in a Hydroid of the family Tubulariidae.—M. LWOFF ("Sur un mode de reproduction asexuée chez un hydraire de la famille des Tubulariidae," *Compt. rend. Acad. des Sci., Paris*, 1926, 183, 914). The undescribed species of *Tubularia* in the Roscoff aquarium, fed on copepods, was seen to detach a hydranth and part of the hydrocaulus. This severed portion became fixed to the bottom of the dish, and in two weeks a new individual, with hydrocaulus of normal height, was formed. This was repeated twice and then degeneration ensued. In each case the decapitated hydrocaulus quickly regenerated a new hydranth. Two other individuals were seen to repeat this process under similar conditions.

Biological Abstracts.

Gonophores of Hydroids.—G. TEISSER ("Notes critiques sur la morphologie des gonophores chez les hydraires," *Arch. Zool. Exp. et Gen. Notes et Rev.*, 1926, 65, 75–86, 6 figs.). Two types of gonophores are described and named: "cryptomedusoid" and "heteromedusoid." While these are entirely homologous, there are certain differences in method of formation and in the structures produced. Cryptomedusoid gonophores possess an umbrellar layer of entoderm and an internal ectoderm; heteromedusoid gonophores lack the former, but have the latter. These are correlated with other types as follows: Gonophores with internal ectoderm, an umbrellar entoderm, originally with four radial canals: Medusæ, Eumedusoid gonophores. Gonophores with internal ectoderm, an umbrellar entoderm reduced to a layer arising directly at the periphery of the anlage of the medusa bud: Cryptomedusoid gonophores. Gonophores having internal ectoderm, but no umbrellar entoderm: Heteromedusoid gonophores. Gonophores having neither internal ectoderm nor umbrellar entoderm: Styloid gonophores, fertile blastostyles. The two types described and figured are further sub-divided: Cryptomedusoid, internal ectoderm preserving its epithelial character, with a sub-umbrellar cavity, gonophores free with velum, *Pachycordyle weissmani*, *Sertularia operculata*; sessile

gonophores without velum, *Cladocoryne floccosa* ♀. Internal ectoderm loses its epithelial character and the gonophores are sessile, without sub-umbrellar cavity, *Cladocoryne floccosa* ♂, *Dynamena pumila*, *Gonothyrax loveni*. Heteromedusoid: Internal ectoderm persisting, *Thuraxia argentea*, *Laomedea conferta*, *Laomedea brochi*; internal ectoderm evanescent, *Laomedea flexuosa*. The author believes that certain details of the development of gonophores may have a greater systematic value than the organisation of the adult gonophore; ultimately such details may be made a part of the diagnosis of genera and families. *Biological Abstracts.*

Protozoa.

Excystation of *Giardia lamblia*.—R. HEGNER ("Excystation and Infection in the Rat with *Giardia lamblia* from Man," *Amer. J. Hyg.*, 1927, 7, 433-47, 18 text-figs.). No satisfactory descriptions of excystation in any species of giardia have yet been given. Rats were infected into the stomach with washed cysts of *G. lamblia* from man. The factors responsible for excystation include a temperature of about 37° C., moisture and possibly certain digestive juices. The process of excystation appears to be as follows: the organism is stimulated to activity within the cyst, the cyst wall weakens at the posterior end, the posterior flagella break through at this point and by their activity draw the rest of the organism out of the cyst wall. Division of the organism into two begins before excystation and is completed afterwards. The nuclei within the cyst are four in number located at one end; the axostyles and other internal structures are duplicated; division begins at the anterior end and proceeds posteriorly. The young trophozoites are smaller than fully-grown specimens and at first are irregular in shape. G. M. F.

Flagellate of an Asclepiad from the Congo.—J. RODHAIN ("Phytoflagellé du latex d'une asclépiadiacée congolaise," *Ann. Soc. belge de Méd. Trop.*, 1926, 6, 271-74, 1 text-fig.). A description of a leptomonas found in an African asclepiad, *Dæmia extensa*; it is related to *L. elmassiani*, which has been observed in an American asclepiad. G. M. F.

Host-parasite Specificity in the Coccidia of Mammals.—J. M. ANDREWS (*J. Parasitol.*, 1927, 13, 183-94). *Isopora felis* and *I. rivolta* from the cat and dog appear to be infective in both animals, though the course of the infection varies in each. With this exception the coccidia of mammals seem to be strictly host specific parasites as judged by cross-infectivity experiments on cats, dogs, rabbits, skunks, opossums, pigs and prairie-dogs. The excystation of the oocyst is facilitated by the digestive processes of the natural host, but in the foreign host oocysts are so resistant to digestive action that the sporozoites are not released during the normal length of time that the organisms pass through the intestine. G. M. F.

Experiments on *Trichomonas*.—J. M. ANDREWS ("Cultivation of *Trichomonas*, Thermal Death Point, Anaerobic Conditions, Attempts at Sterilisation," *J. Parasitol.*, 1927, 12, 148-57). Trichomonads can be cultivated in a serum-saline-citrate medium. A medium containing 2 p.c. of human blood serum allows optimum growth, but 10 p.c. of human serum inhibits growth of *Pentatrichomonas ardin-deckerli*. Trophozoites of the seven species of trichomonads studied were killed at a temperature of 49° C. All species were facultative anaerobes. G. M. F.

Responses by Amœba.—H. T. FOLGER ("The Relation Between the Responses by Amœba to Mechanical Shock and to Sudden Illumination," *Biol. Bull.*, 1927, 53, 405-12). Amœba responds both to mechanical shock and to sudden illumination by a cessation of movement, which does not take place immediately on stimulation, but after a considerable reaction time, which depends upon the magnitude of the stimulus, being longer as the intensity of the stimulating agent increases. After an amœba has been exposed to light, it is necessary for a certain interval of time to elapse before it will again respond to sudden illumination. Likewise, after a mechanical shock, the amœba must be allowed time for recovery before it will respond to a second shock. After a repose to light, time must be allowed for recovery before the amœba will react to mechanical shock, and *vice versa*, facts which render it probable that the processes occurring during the refractory period following the reactions caused by mechanical shock and by sudden illumination are basically the same. G. M. F.

Mitosis in Euglena.—H. L. RATCLIFFE ("Mitosis and Cell Division in *Euglena spirogyra* Ehrenberg," *Biol. Bull.*, 1927, 53, 109-16, 3 pls.). Nuclear division takes place within the nuclear membrane, and no centriole appears. The chromatin in the vegetative nucleus is in the form of paired strands of chromomeres. These shorten and thicken in the prophase and lose their granular appearance, forming the chromosome pairs of the metaphase. The nuclear membrane constricts in the mid line following the movement of the chromosomes to the poles of the nucleus. The endosome lies in the centre of the chromosome mass throughout the process. Early in the prophase it becomes homogeneous, then elongates at right angles to the long axis of the body and constricts in halves preceding the complete constriction of the nuclear membrane. The kinetic elements of the flagellum are derived from the endosome and lie in the nucleus as the intranuclear body. Prior to division this divides, and as the nucleus comes into contact with the base of the reservoir the halves give rise to the blepharoplasts. Two new axial filaments grow out and unite with the original axial filaments. The axial filaments then become widely separated, splitting the original flagellum as they move apart. The two flagella for the daughter organisms are thus formed and grow out to their normal length following division. G. M. F.

Coccidiosis in Mammals.—J. M. ANDREWS (*Am. J. Hyg.*, 1926, 6, 784-798). Coccidiosis in cats has an incubation period of from two to four days. The duration of the symptoms does not usually exceed a week. One attack of coccidiosis seems to render cats and dogs non-susceptible to subsequent infection by the same organism at least for seven months and probably for life. G. M. F.

A New Intestinal Amœba from Man.—C. A. KOFOID ("On *Councilmania dissimilis* sp. nov., an Intestinal Amœba from Man," *Univ. Calif. Publ. in Zool.*, 1927, 31, 7-16, 2 pls.). The new species described is said to occur in the motile, encysted and budding stages in the feces. In the motile stage it has clear pseudopodia. Cysts occur in the one, two, four and eight nucleate phases. Budding of successive amœbulæ through the pore reduces this number of nuclei. Cysts have been observed with average diameters ranging from 11.6 to 17 μ . The nucleus in both motile and encysted stages has a large lateral blob with a little peripheral chromatin elsewhere, and a dispersed, usually central, karyosome. There are eight chromosomes. The percentage of infection in 2,587 persons was 0.4. The relation of *C. dissimilis* to the so-called large race of *E. dysenteriae* is problematical. G. M. F.

Pathological Changes in the Myocardium produced by Sarcosporidia.—G. HASSELMANN ("Alteracoes patologicas do myocardio na Sarcosporidiose," *Bol. Inst. Brasileiro de Sci.*, 1926, 2, 310–26). A new species of sarcosporidia, *Miescheria cruzi*, is described from the heart muscle of the ox. The muscle fibres are atrophied and ruptured and lose their transverse striation. There is a round-celled infiltration with lymphocytes, large mononuclears and some fibroblasts. The interstitial tissue and blood-vessels show similar infiltration. G. M. F.

Bartonella muris.—T. BATTISTINI and P. WEISS ("Contribucion al estudio de la *Bartonella muris*," *Am. Facul. de Med. de Lima*, 1926, 9, 71–80, 1 pl.). Intracorpuseular *Bartonella* bodies were found in the blood of rats in Lima. There may be from 9 to 19 in a single cell; they are rod-shaped and practically of one size, thus differing from *Bartonella bacilliformis* of Oroya fever, which varies in shape and size. G. M. F.

Neuromotor Apparatus in Dileptus.—J. P. VISSCHER ("A Neuromotor Apparatus in the Ciliate *Dileptus gigas*," *Jour. Morph. and Phys.*, 1927, 44, 373–82, 4 figs.). A system of fibres has been found in *Dileptus gigas* which is probably a neuromotor apparatus. A distinct elongated basal rod found near the base of the gullet gives rise to three sets of fibres: (1) a set of heavy fibres radiates out around the funnel-shaped gullet; (2) a pair of heavy fibres pass directly from the basal rod to the band of trichocysts, one on each side, extending to the tip of the proboscis; (3) a set of very delicate branching fibres is distributed over the surface of the organism. This system of fibres is held to be a neuromotor apparatus, because (1) the general structure and appearance of the fibres suggest a neuromotor function, and (2) there is little or no evidence indicating any other function, and because (3) the fibres in this system are connected to the most highly specialised structures in *Dileptus*, and finally, because (4) they are similar to structures found in other forms for which a neuromotor function has been experimentally demonstrated. (Author's Abstract.) R. J. L.

Conjugation in Dileptus.—J. P. VISSCHER ("Conjugation in the Ciliated Protozoon *Dileptus gigas*, with Special Reference to the Nuclear Phenomena," *Jour. Morph. and Phys.*, 1927, 44, 383–415, 26 figs.). In conjugation fusion occurs along the entire oval surfaces of the proboscides of *Dileptus gigas*. Two size-reducing divisions occur in rapid succession immediately preceding conjugation. Only one of the many micronuclei takes part in the process of nuclear reorganisation. All other chromatic material is massed at this time in the posterior portions of the conjugants. The pronuclei are derived from the single active micronucleus, and interchange occurs immediately preceding the separation of the mating individuals. The fertilisation nucleus divides to form two nuclei of diverse size. The smaller one produces 32 or 64 micronuclei, while the larger one divides to produce a like number of macronuclei, each of which finally breaks up into many chromatic granules which form the numerous densely staining nuclear derivatives which are characteristic of the vegetative stage of *Dileptus gigas*. In the early stages of this reorganisation process specimens are frequently found with from two to eight distinct nuclei often arranged in a series as in a beaded nucleus. This condition probably explains the frequent references in literature regarding such a nuclear condition in *Dileptus*. *Dileptus gigas* has, accordingly, in the vegetative stage, a multinucleate condition with reference to the micronucleus and a fragmented or distributed condition with reference to the macronucleus. (Author's Abstract.)

R. J. L.

Studies on Balantidium from the Guinea-Pig.—M. J. SCOTT (*Jour. Morph. and Phys.*, 1927, 44, 417-66, 6 pls., 3 text-figs.). Observations indicate that this *Balantidium* from the guinea-pig is *Balantidium coli*, the form found in the pig and man. Fission and conjugation of this ciliate follow the general course found in a number of other ciliates. During fission the micronucleus divides, and the daughter micronuclei migrate to each end of the macronucleus before the latter divides. In conjugation there are two divisions of the micronucleus, one of these nuclei dividing to form the pronuclei. Pronuclear exchange and fusion are followed by a heteropolar division of the synkaryon, resulting in the formation of the new macronuclear and micronuclear anlagen. The parasite was found in the intestinal tissue of the host. No reproductive stages were found in the cysts. New hosts are invaded through contamination of the food and drink with the cysts.

R. J. L.

Conjugation in Metopus Sigmoides.—L. E. NOLAND ("Conjugation in the Ciliate *Metopus sigmoides* C. and L.," *Jour. Morph. and Phys.*, 1927, 44, 341-62, 6 pls., 42 figs.). Conjugating individuals of *Metopus sigmoides* fuse at the anterior end, the pair presenting the appearance of an inverted letter U. The micronucleus of each conjugant by two successive divisions form four micronuclei. Three of each four degenerate, and the fourth by division forms the pronuclei. Cytoplasm and pronuclei from one conjugant pass over into the other, leaving the old macronucleus and a minimum of cytoplasm behind in the shrunken pellicle of the smaller conjugant, which then separates from the larger one. In the larger ex-conjugant two pronuclei fuse, forming the functional synkaryon; the two residual pronuclei degenerate and disappear. The synkaryon divides. One of the daughter nuclei condenses into the new micronucleus, the other grows into the new macronucleus. The old macronucleus liquefies and is absorbed. The larger ex-conjugant, after losing its cilia, secretes a cyst wall about itself and becomes dormant. The whole process requires at least six days for its consummation. (Author's Abstract.)

R. J. L.

Contractile Vacuoles in Amoeba.—H. C. DAY ("The Formation of Contractile Vacuoles in *Amoeba proteus*," *Jour. Morph. and Phys.*, 1927, 44, 363-72, 6 figs.). The origin of vacuoles as studied by dark-ground illumination reveals the vacuole to be formed from a coalescence of extremely minute droplets. The retaining "wall" of the contractile vacuole is not a permanent structure, but is in the nature of a condensation membrane, totally disappearing with each contraction. The loci of the contractile vacuoles are not permanent, but vacuoles are formed more or less at random. It is unlikely that they are supported in gelled areas, for amoebæ with a dozen vacuoles are quite active and there is no interference with amoeboid movement. Conductivity water increases the size, number, and rate of contraction of contractile vacuoles, which suggests that they may function in maintaining an osmotic gradient as well as in the elimination of metabolic waste.

R. J. L.

Gametogenesis in a Flagellate.—E. CHATTON ("Le gamétogénèse méiotic du flagellé *Paradinium poucheti*," *C. R. Acad. des Sc.*, 1927, 185, 553-55). The sporogenesis of *Paradinium poucheti*, a parasite in the general body cavity of pelagic copepods, has been found to have all the characters of a meiotic gametogenesis, the stages being quite easily followed. There are two somatic mitoses and two meiotic mitoses; the first is heterotypic, the second homotypic. The long duration of the meiotic prophase conforms to that observed in all spermatogenesis or

oögenesis. This is the first example of the existence in a flagellate of a gametogenesis exactly comparable in its behaviour and complexity to a spermatogenesis.

A. G. H.

Two New Protozoan Parasites.—A. PAILLOT ("Sur deux protozoaires nouveaux parasites des chenilles de *Pyrausta nubilalis*," *C. R. Acad. des Sc.*, 1927, 185, 673-75). Two diseases caused by Protozoans in the caterpillar of *Pyrausta nubilalis* are found to be due to a microsporidian and a flagellate respectively. The former is found active in regions of the Jura, affecting the malpighian tubes and glands, which become opaque. The disease is transmissible from one individual to another. In the vegetative stages the individuals are binucleated. The name *Perezia pyrausta* has been given to this parasite. The flagellate is found in the lumen of the malpighian tubes and the cells of the intestinal tube. Certain differences of structure are noticeable between the two forms. Those in the intestine are rich in large chromatophile inclusions; they may or may not have a flagellum at the opening of a protoplasmic cavity in front of the body, at the bottom of which lies the blepharoplast. Those forms inhabiting the malpighian tubes never show any trace of a flagellum; the blepharoplast lies in a deep hollow in front, and the posterior part of the body may contain some small chromatophile granules. This parasite has been called *Leptomonas pyraustæ*.

A. G. H.

The Rôle of the Contractile Vacuole.—E. WOLFF ("Le comportement et le rôle de la vacuole contractile d'une amibe d'eau douce," *C. R. Acad. des Sc.*, 1927, 185, 678-79). Experiments on *Amœbæ* (genus *Portmanella*) in fresh water show that in a healthy individual pulsations of the contractile vacuole occur every 40 seconds, the diastole is slow, the systole brusque and lasting only about one second. The effect of saline mediums is to cause a falling off in rhythm and regularity of the pulsations, and eventually the total disappearance of the vacuole. The latter may be brought into evidence again by changing to a fresh-water medium. Hypertrophy of the vacuole at diastole, a slow systole, and irregularity in the rhythm and beat of the pulsations are morbid symptoms. The activity of this vesicle appears to be in proportion to the activity of the animal. The rôle of the contractile vacuole appears to be that of a standardising agent destined to augment the osmotic pressure of the internal medium in relation to its surroundings.

A. G. H.

Evolutionary Cycle of *Synophrya hypertrophica*.—E. CHATTON and A. LWOFF ("Le cycle évolutif de la *Synophrya hypertrophica* ciliated Fœttingeridæ," *C. R. Acad. des Sc.*, 1927, 185, 877-9). It has already been shown in former papers that the Fœttingeridæ evolve by three phases. In *Synophrya* these three fundamental phases are found in their entirety, comprising a primary stage of encystment on the tegument of a crab, a mobile form in the cast skin of the crab, and a free multiplying form in the surrounding water.

A. G. H.

Metamorphoses and Ciliation of the Fœttingeridæ.—E. CHATTON and A. LWOFF ("Les métamorphoses des Fœttingeridæ (Ciliés) et les transformations de leur ciliature au cours du cycle évolutif," *C. R. Acad. des Sc.*, 1927, 185, 1075-8). This paper deals with the complicated changes in the ciliation of the Fœttingeridæ during the metamorphoses, which has been described in previous papers (*C. R.* 1927, 185, 675-7; 1927, 185, 877-9).

A. G. H.

A Ciliated Parasite of *Clitellio arenarius*.—L. DEHORUE ("Sur un cilié du *Clitellio arenarius* Müller, ses relations avec l'*Opalina* (*Anoplophrya*) filum de Claparède," *C. R. Acad. des Sc.*, 1927, 185, 1219-21). A small ciliate

found in the digestive tube of *Clitellio* shows many resemblances to *Opalina*, although very much smaller. Beneath a buccal groove comparable to that of *A. filum* is a small cavity communicating with the exterior by a canal transversing the oral funnel, which may be interpreted as a cytopharynx. There are numerous alimentary vacuoles in the endoplasm. The body is inflated in front, and tapers gradually, terminating in a point. In this pointed extremity is an axial canal into which the expelled waste matter is thrown—this is the cytoproct. It is suggested that these forms may represent an initial stage of *A. filum*, since the appearance of individuals at a lower level of the digestive tube differing slightly from those described above seems to suggest that they are intermediate between them and *Opalina*, nutrition in these intermediate forms having passed from the holozoic mode to the osmotic one of internal parasites.

A. G. H.

Nuclear Apparatus of Infusoirs.—J. DELPHY ("Sur la constitution de l'appareil nucléaire chez les infusoires, les anoplophryimorphes," *C. R. Acad. des Sc.*, 1927, 185, 1323–25). The action of acetic carmine (Schneider) on the macronucleus of *Anoplophrya* reveals successive zones showing variations in their affinity for the dye. Following such techniques as that of Heidenhain or Barda, staining with iron hæmatoxylin colours only a band more or less attenuated at either end, and which is granular and irregular. If Bordeaux R. or Safranin be combined with iron hæmatoxylin, the latter colours only a central axial part. Apparently the macronucleus consists of an internal badly delimited substance surrounded by one of a different nature. The micronucleus appears as a small compact mass, which stains evenly and very definitely with iron hæmatoxylin.

A. G. H.

The Nucleus of Certain Trypanosomes.—G. LAVIER ("Particularités du noyau chez les trypanosomes du groupe brucei, d'isolement récent," *C. R. Acad. des Sc.*, 1927, 185, 1325–27). Observations on the nucleus of *T. gambiense*, *T. rhodesiense*, and *T. brucei*, reveal the following facts. The nucleus is usually central, but may be found displaced forwards or backwards, except in *T. gambiense*. In the living animal it is not visible except when stained up with certain intravital dyes, e.g. pyronine. Individuals possessing no nucleus whatever are not uncommon. Their origin is remarkable. The necessary synchronism in the division of the cell for the formation of two complete new individuals is no longer observed—a delay in the division of the nucleus causing one of the new-formed individuals only to hold it; the other has no nucleus whatsoever. These forms without a nucleus may be quite vigorous and strong at first, but must eventually die.

A. G. H.

A New Eccrinide Parasite in Orchestia.—R. POISSON ("Sur une eccrinide nouvelle, *Tæniellopsis orchestie* nov. gen., nov. sp., protophyte parasité du rectum de l'*Orchestia botta* M. Edw. (Crust. amphipode), son cycle évolutif," *C. R. Acad. des Sc.*, 1927, 185, 1328–29). The Eccrinide is exclusively localised in the posterior part of the rectum of *Orchestia*, where it adheres. The adult stages consist of almost rectilineal filaments, about $1,200\mu$ long. The very young stages are club-shaped, about $30\text{--}35\mu$ long and 12μ broad. At the free end is a swollen gland, apparently fertile, which in adult forms withers away. The adult filaments may give rise to macroconidia, microconidia, or durable spores; the conidia, on escaping from the filament, fix themselves on to the rectal skin and begin to develop into the young stages. The spores are formed by the segmenting of the distal end of an adult filament into uninucleated masses. They are expelled from the filament, just as the host moults, by the contracting and rolling up into a spiral of the sporiferous filament.

A. G. H.

Flagellate Parasite of *Maniot palmata*.—H. DE BEAUREPAIRE ARAGO ("Sur un flagellé du latex de *Maniot palmata*, *Phytomonas françai* n. sp.," *C. R. Soc. Biol.*, 1927, 97, 1077–80). Plants attacked by the parasite show no external indication. The life-history is very characteristic, and easily differentiates it from allied parasites found in other plants. The parasite is found in the tissues of *Mainot palmata*. The body is long (25–40 μ) and narrow and very mobile. The posterior end may be twisted several times, and terminates in a point. Nucleus lies at the anterior end immediately behind the blepharoplast, near which arises a flagellum. Multiplication is by binary and multiple fission. A. G. H.

***Enteromonas hominis*.**—O. DA FONSECA ("Sur le flagellé *Enteromonas hominis*," *C. R. Soc. Biol.*, 1927, 97, 1086–87). The parasite is widespread in distribution and presents both binary fission and multiple division. The nucleus often shows a central karyosome, very small, surrounded by a zone of nuclear fluid. The chromatin and nuclear membrane are not clearly seen. At division the nucleus elongates and becomes ovoid, whilst the chromatin condenses to form an equatorial plate. The basal body divides them into two portions. The division of the nucleus proceeds, though the details cannot be followed in preparations stained by the Heidenhain method. Multiple division appears to consist only of a series of binary divisions of the nucleus and basal body, without division of the protoplasm. The formation of five new individuals from one by this method has been observed. A. G. H.

Relationship of Three Giliated Parasites.—A. DA CUNHA and J. MUNIZ ("Sur les genres *Prototapirella*, *Tripalmaria*, *Tricaudalia*," *C. R. Soc. Biol.*, 1927, 97, 1088–90). This paper deals with the relationship of the following ciliated parasites: (1) *Prototapirella*, described by Cunha (1918) in *Tapirus americanus*, belonging to the family Cycloposthiidæ; (2) *Tripalmaria*, described by Gassowski (1919) in the horse; (3) *Tricaudalia*, described by Buisson (1923) as a new species, in the rhinoceros. Buisson thought *Tricaudalia* to be intermediate between Cycloposthium and *Prototapirella*. It is now realised that *Tricaudalia* and *Tripalmaria* are synonyms, priority being given to the latter, since it was described in 1919. Specimens of *Tripalmaria* have since been found in *Tapirus americanus*. It has been found that *Prototapirella* divides to form two individuals which have all the generic characters of *Tripalmaria*. These new individuals become transformed without any divisions into the *Prototapirella* form simply by the development of an additional caudal appendage. The abundance of the *Prototapirella* form suggests that it is the habitual adult stage of this parasite. Originally it was thought the three forms, *Prototapirella*, *Tripalmaria*, and *Tricaudalia*, represented three separate genera. A. G. H.

***Trichomonas*.**—A. DA CUNHA and J. MUNIZ ("*Trichomonas aragaoi*," *C. R. Soc. Biol.*, 1927, 97, 1349). This is a new species. The body is large, ovoid or globular, 5–7 μ long and 4 μ wide. The anterior end bears three flagella of equal lengths, which are inserted into a basal body, from which arises also a recurrent flagellum which follows the free edge of an undulating membrane and terminates in a free flagellum at the posterior end. The nucleus lies at the anterior end, and is large and rounded, carrying a small karyosome; it is poor in chromatin. The flagellate has an axostyle. This species is found in the large intestine of *Tamandua tetradactyla*. It is distinguished from *Trichomonas tatusi*, which it resembles in many ways, by the clearness of its axostyle and the length of the flagella, which does not exceed that of the body. A. G. H.

Intracellular Stage of *Trypanosoma cruzi*.—G. DA FARIA and O. CRUZ ("Sur l'existence d'un stade évolutif intracellulaire du *Trypanosoma cruzi* dans *Triatoma megista*," *C. R. Soc. Biol.*, 1927, 97, 1355-57). The evolutionary intracellular stage of *T. cruzi* was first described by Meyer and Rocha Lima. The work of da Faria and Cruz confirms these observations. The parasite is found, in the intracellular stages, in the epithelial lining cells of the digestive tube, and may be isolated or in groups varying in size. The individuals are ovoid or pyriform ($4-6\mu$), carrying a spherical nucleus and blepharoplast. As a rule, there is no flagellum. In addition to these, one comes across the true trypanosome type, though less frequently. Sometimes the cells contain masses of individuals representing both types. The parasites, as a rule, are lodged in a vacuole of the protoplasm. The tendency for intracellular forms is found in man as well as in insects. It is thought that this stage is indispensable if the *Triatoma* is to become truly infecting.

A. G. H.

Endogenous Cycle of *Hemogregarina*.—A. DA CUNHA and J. MUNIZ ("Sur le cycle endogène d'*Hemogregarina leptodactyli* Lesage, 1908," *C. R. Soc. Biol.*, 1927, 97, 1351-54). A complete study of the evolution of *Hemogregarina leptodactyli* in its vertebrate host has been carried out. Examination of the stages in the blood show that variations occur between those individuals which are free in the plasma and those which are endoglobular. The free forms are more numerous than the latter, and are long and vermiform; the endoglobular forms are short and wide. Examination of sections of the intestine and liver has revealed stages of multiplication. Multiplication takes place by schizogony, of which there are two types—one in which the number of merozoites produced is 2-8, the other where the number is about 32. This phase appears to occur only in the cells of the organs, not in the blood. The merozoites formed from schizogony, as soon as they are set free, penetrate into another cell and there undergo schizogony again. After a number of such multiplications, certain individuals form a large number of merozoites; these, when set free, work their way into the circulatory system and parasitise the blood.

A. G. H.

Trypanosomes without a Parabasal Body.—G. LAVIER ("Existence d'individus naturellement 'ablepharoplastique' dans les souches de trypanosomes du groupe brucei," *C. R. Soc. Biol.*, 1927, 97, 1611-13). Investigations on *Trypanosoma gambiense*, *T. brucei*, and *T. rhodesiense*, show that all these species contain naturally a certain proportion of individuals deprived of a parabasal body. These forms can live in the host naturally infected, they behave as ordinary individuals, and divide to give rise to individuals which will thus perpetuate the race. The origin of these forms deprived of a parabasal body is interesting. Some of them quite probably arise through the atrophy of the body, but this will not account for all the cases. At division if the necessary synchronism, in order that the two new individuals may be complete, is not in evidence, i.e. if there is a delay in the division of the parabasal body, or a quickening in the division of the other cell constituents, then one of the new individuals will retain the parabasal body, the other will have none. The existence of individuals without a parabasal body in *T. brucei* explains to us the appearance in South America of *T. equinum*, which differs from *T. evansi* only by the absence of a parabasal body.

A. G. H.

Pro-Mitotic Nuclear Division in *Vahlkampfia pædophthora*.—MOMDICO IVANIĆ ("Zur Kenntnis der promitotischen Kernteilung bei *Vahlkampfia pædophthora* (Caullery)," *Zool. Anzeiger.*, 1926, 66, 277-86, 16 figs.). *V. pædophthora*, parasitic in the ova and early cleavage stages of *Peltoaster curvatus*, is a facultative

parasite, since the ova are only available seasonally. It belongs in *Vahlkampfia* (as done by Nöller) instead of *Amœba*, in which it was described by Caullery. A re-examination of Caullery's preparations has made possible a complete account of nuclear division. The nucleus is vesicular with large eccentric karyosome, definite nuclear membrane remaining intact during division and a clear area in which chromatin granules may be found in nuclei not too completely destained. At division the karyosome constricts and forms polar caps, a linen spindle forming between these caps. The equatorial plate appears as a row of small granules which part in metaphase. Division is completed by a constriction, stretching out, and parting of the nuclear membrane between the separating nuclei. A second type of division was occasionally seen in which the equatorial plate was massive and occasionally bipartite. The two masses are interpreted as emerging chromosomes. Parasitism by amœbæ has had its evolutionary origin in amœbæ of the limax type with facultative parasitic tendencies. *Biological Abstracts.*

Classification of the Coccidia of the family Diplosporidæ.—A. HENRY and C. LEBLOIS ("Essai de classification des coccidies de la famille des Diplosporidæ Léger, 1911 (Diplosporidæ)," *Ann. Parasitol. Hum. et Compar.*, 1926, 4, 22-28, 6 figs.). In addition to the character of shape of the sporocysts, which is a valid basis for separating the genera *Isospora* and *Hyaloklossia*, there should be considered the arrangement of the sporozoites in the sporocysts. *Biological Abstracts.*

How are Coccidial Sporozoites freed from their Envelope in the Intestinal Tract of the Host?—B. J. KRIJGSMAN ("Wie werden im Intestinaltractus des Wirtstieres die Sporozoiten der Coccidien aus ihren Hüllen befreit?" *Arch. Protistenk.*, 1926, 56, 116-27, 1 fig.). After summarising previous literature on coccidial excystation in vivo and in vitro, the writer describes his own experiments on this point. He finds that excystation is normally due to, and can be artificially produced by, the consecutive action of gastric and intestinal enzymes, and that only completely sporulated oocysts are susceptible to this influence. *Biological Abstracts.*

Coccoliths and Arenaceous Foraminifera.—E. LACROIX ("De l'emploi des coccolithes par les foraminifères arenaces pour l'edification de leurs testes," *Compt. rend. Acad. des Sci., Paris*, 1926, 183, 430-1). Coccoliths have not hitherto been recorded as one of the materials of the test in arenaceous Foraminifera. From dredgings near Rockall Bank specimens of several species were obtained, in which some had made the test entirely of coccoliths, giving a much neater appearance than when sand grains were used. Solution by acid leaves the usual chitinous lining, and the cementing material by chemical tests shows the presence of iron salts, a characteristic feature of the arenaceous group of Foraminifera. *Biological Abstracts.*

Chilomitius lagostomi Fonseca, 1916.—G. LAVIER ("Note sur le *Chilomitius lagostomi* Fonseca, 1916," *Ann. Parasitol. Hum. et Compar.*, 1926, 4, 341-44, 10 figs.). From a study of specimens from the intestine of *Viscacia viscacia* from Brazil the author concludes that the genus *Chilomitius* Fonseca, 1915 (Mastigophora, Tetramitidæ) is perfectly valid and far removed from *Chilomastix*, with which Chalmers and Pekola, 1917, had placed it. Contrary to Fonseca, it possesses an axostyle and a complicated blepharoplastic apparatus. Cystic forms are rare and may be either uni- or quadri-nucleate. *Biological Abstracts.*

Some Features of Structure and Behaviour in *Vampyrella lateritia*.—F. E. LLOYD (*Science*, 1926, 63, 364–65). The structure of the organism and its manner of feeding upon the cells of *Spirogyra weberi* are described. Special reference is made to small contractile vacuoles lying within the hyaline margin of the animalcule.
Biological Abstracts.

The Structure and Division of *Paramecium trichium* Stokes.—D. H. WENRICH (*Jour. Morph. and Physiol.*, 1926, 43, 81–103, 2 pls., 1 fig.). *P. trichium* is 50–105 μ long (most individuals 80–90), the width is one-third to one-half the length. It is somewhat depressed dorsoventrally. The broad buccal groove extends from the anterior left border diagonally across the ventral surface to the mouth, which is usually slightly anterior to the middle and to the right of the median line. The mouth leads into a relatively long cytopharynx which contains an undulating membrane. The cytopyge is sub-terminal and the small caudal tuft of longer cilia is sub-apical. The plastic extosarc contains numerous trichocysts. A contractile vacuole apparatus, each deeply located and staining more intensely than surrounding protoplasm, occurs near either end. In life each appears to consist of two alternately contracting vacuoles with smaller feeding vacuoles adjacent. Contractions are 15–25 per minute. The macronucleus is medium in size and the single micronucleus is of the “caudatum” type. Binary fission appears to be initiated by a metaphase-like condition of the micronucleus, followed by great enlargement and eventual separation of chromatin threads into two anaphase groups. The metaphase thus appears to precede the changes corresponding to a prophase in other cases. An intradesmose appears in many of the stages. The macronucleus appears to “untwist,” then elongate and constrict in the middle as the body divides. During division of the body the two old contractile vacuoles persist as the posterior ones for the daughters, new anterior ones being developed.
Biological Abstracts.

BOTANY.

(Under the direction of A. B. RENDLE, D.Sc., F.R.S.)

GENERAL.

Cytology.

Inheritance in *Nicotiana tabacum*.—R. E. CLAUSEN and T. H. GOODSPEED ("Inheritance in *Nicotiana tabacum*. VII. The Monosomic Character, 'Fluted,'" *University of California Publications in Botany*, 1926, 11, 61–82, 3 pls., 2 text-figs.). The paper deals with a form "fluted" which occurs spontaneously in cultures of *Nicotiana tabacum*, the ratio of appearance being about 1:150. On cytological examination it is found to be a monosomic mutation ($2n - 1$). Characteristics of the fluted form are the decrease in flower size, the folded or fluted appearance of the corolla, and the short stamens. The normal chromosome number for *N. tabacum* is $n=24$. Studies of transmission for fluted show that about 60 p.c. of the functioning female gametes and 2 p.c. of the functioning male gametes are of the 23 chromosome class. Expectations calculated on these percentages are, however, in excess of results obtained by selfing fluted. Experiments prove that the aberrations causing fluted occur in a different pair of chromosomes from those causing enlarged, a trisomic ($2n + 1$) form, and are also independent of five other linkage groups. Crosses between fluted ♀ and *sylvestris* ♂ give an F_1 of two distinct classes, normal and fluted *sylvestris-tabacum* hybrids, whose morphological differences are more distinct than those of normal and fluted *tabacum*, particularly in flower colour. Cytological observations show the fluted *tabacum* mutant to have 23 bivalent chromosomes and a univalent. The unpaired chromosome is designated as F, and the pronounced differences between normal and fluted *sylvestris-tabacum* hybrids are believed to be due to the fluted hybrid being nullo-F, and, as such, not comparable with fluted *tabacum* which is haplo-F. Evidence supporting this assumption is obtained from a bud variant in fluted *tabacum* which differs markedly in colour from normal *tabacum*. The explanation offered is that the variant arose through the establishment of the nullo-F condition in the epidermal tissues by elimination of the single F chromosome of fluted. J. L.

Interspecific Hybridisation in *Nicotiana*.—R. E. CLAUSEN and T. H. GOODSPEED ("Interspecific Hybridisation in *Nicotiana*. III. The Monosomic *Tabacum* derivative, 'Corrugated,' from the *Sylvestris-tabacum* hybrid," *University of California Publications in Botany*, 1926, 11, 83–101, 3 text-figs.). An abnormal *N. tabacum* derivative was established by self-fertilising a partially fertile plant resulting from the back-cross of the F_1 *macrophylla-sylvestris* hybrid to *macrophylla* (a variety of *tabacum*). This derivative, called "corrugated" on account of its distinct leaf type, shows numerous morphological differences from the normal *tabacum* var. *macrophylla*. On cytological examination it is found to be a monosomic mutation ($2n - 1$) with 23 bivalent and 1 univalent chromosome. Crosses of corrugated with white *tabacum* show that the unpaired chromosome C

is responsible for coloured flowers. It is assumed that C is one of the univalents in the *sylvestris-tabacum* hybrid ($n = 12$, and $n = 24$ respectively), and that the corrugated condition arose through union of a nullo-C gamete with a normal *tabacum* gamete. As with "fluted," ovule transmission for corrugated is over 50 p.c. accompanied by a very low ratio of pollen transmission. J. L.

Chromosomes in Nicotiana Hybrids.—T. H. GOODSPEED, R. E. CLAUSEN, R. H. CHIPMAN ("Some Cytological Features of the *Paniculata-rustica* hybrid and its derivatives," *University of California Publications in Botany*, 1926, 11, 103-15, 6 text-figs.). The haploid chromosome number for *paniculata* = 12, for *rustica* = 24. In diakinesis of the F_1 hybrid 12 bivalents and 12 univalents are present. The univalents do not divide, but undergo random distribution in the heterotypic anaphase. Plants obtained by back-crossing the F_1 hybrid ♀ with *paniculata* ♂ show, in the heterotypic division, 12 bivalents and a variable number of univalents (usually 12) distributed at random. Sometimes division of the univalents occurs. The same F_1 *rustica-paniculata* plant ♀ was back-crossed with *rustica* ♂. Of the derivatives from this cross, 13 plants were examined cytologically. Seven were found to have 18 bivalent and 6 univalent chromosomes, four to have 20 bivalents and 4 univalents, and two to be of doubtful constitution. The genetic significance of the cytological data is discussed.

J. L.

Hybrids of Nicotiana.—V. A. RYBIN ("Polyploid Hybrids of *Nicotiana tabacum* L. × *Nicotiana rustica* L." Russian with English summary. *Bulletin of Applied Botany, Genetics and Plant Breeding*, 1927, 17, 191-240, 8 pls.). The paper is a preliminary communication of the results of cytological investigations of two hybrid individuals of *Nicotiana tabacum* (Dubek) × *N. rustica* (Kolmak). Both parental varieties possess 48 somatic chromosomes. From the *tabacum-rustica* cross, an F_1 of eight plants was obtained. Six of these resembled *tabacum*, while two differed morphologically and had sterile pollen. One of these latter (the hybrid plant TR_1) was investigated cytologically, and proved to be triploid ($2x = 72$). From the pollination of TR_1 with *N. rustica* var. *texana* pollen, five plants intermediate between *tabacum* and *rustica* were obtained. One of these normally fertile plants was submitted to cytological examination and found to be tetraploid ($2x = 96$). Cytological observations on the meiotic divisions lead to the supposition that both hybrids have originated as the result of equational division of the univalent chromosomes instead of pairing and reduction in the first meiotic division of the seed parent. The triploid hybrid thus has 48 *tabacum* and 24 *rustica* chromosomes, which agrees with its greater external similarity to *N. tabacum*. The meiotic divisions of this hybrid are extremely irregular, and account for its high degree of sterility. The tetraploid hybrid has the 72 chromosomes of the triploid plus 24 *rustica* chromosomes from the pollen parent. Externally its characters are nearer those of *rustica* than are those of the TR_1 hybrid, and fertility results from the regular conjugation of the 48 *tabacum* and 48 *rustica* chromosomes. The hybridisation experiments were performed during cold weather. Anthers of Dubek fixed at low temperatures also show meiotic stages with the somatic number of chromosomes.

J. L.

Chromosomes in Crepis Hybrids.—M. S. NAVASHIN ("On the Variation of the Number and Morphological Characters of the Chromosomes in Interspecific Hybrids." Russian with English summary. *Bulletin of Applied Botany, Genetics and Plant Breeding*, 1927, 17, 121-50, 9 text-figs.). The following hybrids

obtained artificially were investigated: *Crepis capillaris* \times *C. tectorum*, *C. capillaris* \times *C. aspera*, *C. capillaris* \times *C. parviflora*, and *C. fastida* \times *C. rubra*. One result of hybridisation is the formation of gametes with the somatic number of chromosomes. This is due to equational division of each of the univalent chromosomes in the first meiotic division instead of pairing and reduction. A mechanism is thus found accounting for the production of forms with the double chromosome number. Hybridisation also results in the variation of morphological characters of definite chromosomes, e.g. the loss of a characteristic satellite from a *tectorum* chromosome in the F_2 of *C. capillaris* \times *C. tectorum* and its replacement by an enlarged head. These changes may appear at once in F_1 , or only be manifest in F_2 , thus depending not only on the interaction of alien nuclei, but also on the period of duration of this interaction. The author states that in natural conditions constant forms with changed chromosome composition may arise as a result of hybridisation, which thus appears as one of the most important factors of evolution.

J. L.

Datura Mutants.—A. F. BLAKESLEE, GORDON MORRISON, and A. G. AVERY ("Mutations in a Haploid *Datura*," *Jour. Heredity*, 1927, 18, 193-99, 4 figs.). *Datura Stramonium* has a diploid chromosome number of 24. Haploid plants are known to develop parthenogenetically from a single 12-chromosome egg cell. The spontaneous occurrence in F_1 of trisomic ($2n + 1$) types from selfing a haploid parent is considerably more frequent than that either from ($2n + 1$) parents or from normal diploid parents, the percentages of occurrence being 3.05, 1.11, 0.47 respectively. Gene mutations are normally rare in *Datura*, but 2 (possibly 4) have occurred in 173 individuals obtained from selfing one plant of the F_1 from the first known haploid mutant. These two gene mutants are described as "curled" and "tricarpele," the former differing from normal only in the juvenile stages, while the latter shows abnormalities in floral organs, leaves and stems. They are shown to be located in the *Poinsettia* and reduced the chromosomes respectively.

J. L.

Pollen Tube Growth in a *Datura* Mutant.—J. T. BUCHHOLZ and A. F. BLAKESLEE ("Abnormalities in Pollen-Tube Growth in *Datura* due to the Gene 'Tricarpele,'" *Proc. National Acad. Sciences*, 1927, 13, 242-49). "Tricarpele" is a recessive gene mutant of *Datura Stramonium*. In the F_2 generation following the cross between tricarpele and normal there is a marked deficiency in the number of recessive phenotypes obtained. By back-crossing it is found that there is a large elimination of the tricarpele (tc) element from the (Tc)(tc) pollen. Pollen of the three types (tetc), (Tc)(tc) and (Tc)(Tc) was grown on pistils of the same three types in all possible combinations. Microscopical examination reveals the fact that the pollen tubes carrying the gene (tc) are subject to a high proportion of bursting within the styles of normal plants, their own styles or those of heterozygotes, thus greatly reducing the number which reach the ovary to transmit the (tc) gene. The protoplasm which is extruded from the burst pollen tubes of (tc) constitution differs in appearance from that of the burst (Tc) pollen tubes. The gene is transmitted with practically no elimination through the female. It is suggested that such gametophytic selection may have been an important factor in evolution.

J. L.

A *Datura* Mutant.—A. F. BLAKESLEE ("Nubbin, a Compound Chromosomal type in *Datura*," *An. New York Acad. Sciences*, 1927, 30, 1-29, 8 pls., 8 text-figs.). Nubbin is a ($2n + 1$) mutant of *Datura Stramonium*. It appeared in 1921 among the offspring of a normal ($2n$) diploid plant which had been treated with radium

emanation, and has not appeared spontaneously since. In its offspring it throws normal diploids, two new types, Pinched and Hedge, each also with an extra chromosome, and two primary ($2n + 1$) types, Buckling and Echinus. Pinched throws Buckling, Hedge throws Echinus, while both throw the primary Rolled which is not thrown directly by Nubbin. Considerable data are given concerning Nubbin and other mutants of *Datura*. From these, and a consideration of its morphological characters, Nubbin is considered to have the following chromosomal formula: $-2n - 1$ Rolled $+ \frac{1}{2}$ Strawberry $\frac{1}{2}$ Sugarloaf $+ \frac{1}{2}$ Mutilated $\frac{1}{2}$ Polycarpic. Chromosomal diagrams are given for Nubbin, indicating its probable constitution and the methods of disjunction that might lead to the formation of Normal, Nubbin, Pinched and Hedge gametes. The chromosomal constitution shows that more than a single compound chromosome made up of segments from non-homologous chromosomes may be present in a plant without greatly affecting its vigour of growth. The analysis of the Nubbin mutant shows the possibility of alterations in the morphology of a plant being brought about by shifts in large groups of genetic factors contained in the chromosomes, i.e. by segmental interchange between non-homologous chromosomes, and thus may contribute toward an understanding of a method of evolution.

J. L.

Raphanus-Brassica Hybrids.—G. D. KARPECHENKO ("Polyploid Hybrids of *Raphanus sativus* L. \times *Brassica oleracea* L." Russian with English summary. *Bull. Appl. Botany, Genetics, etc.*, 1927, 17, 305-408, 2 pls., 51 text-figs.). The diploid chromosome number of both parental forms is 18. The cross of F_1 hybrids with *Raphanus* gives triploids and pentaploids with 27 and 45 chromosomes respectively, and selfing and crossing F_1 hybrids *inter se* produces tetraploids with 36 and forms with 51-53 chromosomes. In the hybrids the fruit structure shows clear correlation with karyological features, e.g. in diploids an intermediate siliqua is formed, whereas in triploids having 18 *Raphanus* and 9 *Brassica* chromosomes the siliqua is two-thirds non-dehiscent, thus demonstrating the influence of the *Raphanus* chromosomes, and one-third dehiscent as in *Brassica*. The results are given of the study of the pollen mother-cell divisions in the hybrids, and also the results of free pollination of the hybrids, crossing the hybrids with each other, and with the parental species. The progeny of the tetraploids alone proves uniform.

J. L.

Chromosomes of Beta.—N. E. KUZMINA ("On the Chromosomes of *Beta vulgaris* L." Russian with English summary. *Bull. Appl. Botany, Genetics, etc.*, 1927, 17, 241-52, 1 pl., 2 text-figs.). The 18 somatic chromosomes of *Beta vulgaris* var. *saccharifera* exhibit a series of distinct morphological types consisting of articulations varying in size, shape and arrangement. The entire chromosomes are also themselves very different in size. The author has also investigated *B. maritima*, the wild form of *B. vulgaris*, and finds all the chromosomes very uniform in their dimensions. The complication of the chromosome group of the cultivated sugar beet is therefore a factor for consideration when investigating the problem of its phyletic origin.

J. L.

Chromosomes in Linum.—K. K. MARTZENITZINA ("The Chromosomes of some Species of the genus *Linum*." Russian with English summary. *Bull. Appl. Botany, Genetics, etc.*, 1927, 17, 253-64, 1 pl.) Ten species of *Linum* have been investigated, which may be divided into five groups according to number, size and shape of chromosomes. In the first group are *austriacum*, *tenusfolium*, *corymbiferum*, *punctatum* and *perenne*, characterised by 18 ($2x$) chromosomes, which are elongated, curved and slightly constricted. *L. grandiflorum* forms the second group

with 16 ($2x$) chromosomes, resembling group one except for a more marked constriction. The third group comprises *L. usitatissimum* and *L. angustifolium*, each with 32 ($2x$) chromosomes, short, curved and tapered. The fourth group is of *L. flavum* alone with 30 or 32 ($2x$) chromosomes, long, curved, and frequently overlapping, rendering accurate counts difficult. The fifth group is also of only one species, *L. catharticum*, with more than 57 very small chromosomes. The exact number could not be established. The genus is thus karyotypically not homogeneous. The chromosome differences are in agreement with certain systematic variations. J. L.

Karyological Studies on Vicia.—I. N. SVESHNIKOVA ("Karyological Studies on Vicia." Russian with English summary. *Bull. Appl. Botany, Genetics and Plant Breeding*, 1927, 17, 37-72, 4 pls., 2 text-figs.). A preliminary survey of the correlation between karyological features and external morphology in the genus *Vicia*. The genus includes diploid forms with 12 and 14 chromosomes, and tetraploid forms with 24 and 28 chromosomes. The chromosomes have constrictions, heads or satellites, and can be grouped in four classes according to their shape. There is correlation between the length of the arms of the chromosomes and (1) the character of pubescence of the style, (2) the length of the peduncle of the inflorescence. The nuclei of different species show marked internal differences, thus accounting for the failures of interspecific crosses. In the genus there are two principal processes of evolution of the nucleus, the process of reduction of chromatin, and that of increase of chromatin by polyploidy. J. L.

Effects of Reagents on Chromosomes of Vicia.—R. O. EARL ("The Nature of Chromosomes. I. Effects of Reagents on Root Tip Sections of *Vicia Faba*," *Bot. Gazette*, 1927, 84, 58-74, 19 text-figs.). The author introduces his subject by briefly mentioning some of the more important works which demonstrate that the chromosome theory of heredity rests upon a secure foundation of fact, and outlining the two main theories as to the physical constitution of the chromosomes, i.e. the alveolation and chromonema hypotheses. Root-tips of *Vicia Faba* were chosen for study, and the comparative effects of various fixing agents observed. Sections of material fixed in Carnoy's fluid were also treated with solutions of tribasic sodium phosphate, acid sodium phosphate, sodium phosphate at pH_5 , sodium hydroxide and pepsin hydrochloric acid respectively. Tribasic sodium phosphate, a solvent of chromatin, has the greatest effect and reveals the internal structure of the late prophase chromosomes as two spirally twisted threads. No internal structure of anaphase or telophase chromosomes is observed, and it is suggested that during prophase the chromonemata are reinforced by and react with material from the nucleolus (which is seen clearly to consist of two substances) to form a substance soluble in sodium phosphate. The physical basis of Mendelian heredity may be an ultra-microscopic thread of genes with a fluctuating attraction for chromatin, thus causing the periodic formation and dissolution of chromosomes. The visible parts of the chromosomes would thus form the environment of the genes, and changes in the protein constituents of the chromosomes would probably profoundly affect the reactions of the genes and result in mutations. J. L.

Chromosomes of the Cultivated Apple.—V. A. RYBIN ("On the Number of Chromosomes observed in the Somatic and Reduction Divisions of the Cultivated Apple in connection with Pollen Sterility of some of its Varieties." Russian with English summary. *Bull. Appl. Botany, Genetics, etc.*, 1927, 17, 101-20, 6 pls.). The somatic number of chromosomes in all investigated varieties is 34. In Reinette de Champagne and Winter Golden Pearmain triploids with 51 chromosomes are

observed in addition to normal diploids. Irregular reduction divisions occur in Canadian Reinette, both in the anthers and ovary. Instead of pollen tetrads, pentads and hexads are formed, resulting in grains possessing different numbers of chromosomes. This variety is proved to be triploid, possessing 51 chromosomes.

J. L.

Meiotic Irregularities in *Potentilla*.—MURIEL V. ROSCOE ("Meiotic Irregularities in a Gigas Form of *Potentilla anserina*," *Bot. Gaz.*, 1927, 84, 307-16, 1 pl., 2 text-figs.). Cytological investigation has been made of an abnormal form of *Potentilla anserina* which is characterised by gigantism, sterile pollen and lack of fruit formation. Numerous irregularities are observed in the dividing pollen mother-cells. Bivalents, univalents, lagging chromosomes and irregular distribution of chromosomes are conspicuous during the heterotypic division. Micronuclei are frequently formed. The homotypic divisions are abnormal, and lead to the condition of polycary (several small nuclei). Twenty-two chromosomes (and variable numbers) have been observed during these divisions, but no statement is made of a definite chromosome number for the *gigas* plant. The number 16 has previously been recorded for *P. anserina*. These observations, therefore, do not establish the tetraploid condition for the *gigas* form. The irregularities observed are compared with the results of other investigators on plants of known hybrid origin, and on the basis of irregular meiotic features, this *gigas* form of *P. anserina* is considered to be a hybrid.

J. L.

Certain Meiotic Stages in *Oenothera*.—F. M. L. SHEFFIELD ("Cytological Studies of Certain Meiotic Stages in *Oenothera*," *Ann. Bot.*, 1927, 41, 779-816, 3 pls., 3 text-figs.). Certain meiotic stages of the pollen mother-cell nuclei of five different species of *Oenothera* are described—*O. novae-scotiae*, *O. eriensis*, *O. rubricalyx*, *O. ammobila*, and *O. Agari*. In each of these forms the diploid number of chromosomes is 14. The resting and early prophase stages are very similar in all these species and are similar to those described for other forms. Certain nucleolar inclusions are, however, observed. A large crystalloid may be present within a vacuole in the spherical nucleolus of the resting nucleus. This crystalloid later gives off successive fragments which ultimately disappear. When the reticulum has given place to a long fine spireme and the now biconvex nucleolus has become apposed to the nuclear membrane, the nucleolus includes a small dark-staining body, the endonucleolus. One or occasionally more loops of the spireme are attached to this inclusion, which persists until the unfolding of the second contraction knot. Eventually the thickened thread breaks away from the nucleolus and the endonucleolus disappears. The time of occurrence of the second contraction phase and the period occupied by it vary in different species. Segmentation of the spireme occurs about this time. During "diakinesis" the chromosomes are not usually paired, but are linked together in long closed chains, most species having their characteristic configuration: *O. novae-scotiae* and *O. eriensis* each show a ring of 14 chromosomes in "diakinesis"; *O. ammobila*, a ring of 12 chromosomes and a separate ring pair; *O. rubricalyx*, a ring of 6 and 4 bivalents. The arrangement assumed in "diakinesis" persists into the "metaphase," when adjacent chromosomes of the rings become attached to fibres emanating from opposite poles, resulting in a zigzag arrangement. Any pairs of chromosomes which have been cut off assort independently. At anaphase the linked chromosomes become V-shaped and adjacent ones pass to opposite poles. *O. Agari* shows no regularity either in "diakinesis" or "metaphase." Irregularities in the constitution of the rings and in the mode of segregation at anaphase

are occasionally observed in the other species. In some cases these irregularities are of importance genetically. Where linkage of chromosomes occurs it is reasonable to suppose that homologues occupy adjacent positions in the spireme. Each linkage group acts as a unit in heredity, whilst characters borne by the pairs will be inherited in the normal Mendelian manner. Possible causes of this type of linkage and its relation to hybridity are considered and its general genetical significance is briefly discussed. J. L.

The Karyotype of *Solanum tuberosum*.—G. A. LEVITSKY and G. K. BENETZKAJA ("On the Karyotype of *Solanum tuberosum*." Russian with English summary. *Bull. Appl. Botany, Genetics, etc.*, 1927, 17, 289–303, 1 pl., 11 text-figs.). Three varieties of potato have been investigated "Tannenzapfen," "Woltmann" and "Pirozhok." In each there is a marked variation in the shape and number of chromosomes at different stages in nuclear division. The somatic number of chromosomes in each variety is 48. The change in chromosome shape from simple elliptical bodies to dumb-bell shaped or tri-articulate structures, or even completely fragmented bodies, renders chromosome counts very unreliable at the stages where these changes occur, and will account for the varying numbers given by different workers. The authors distinguish between this change in shape and the "fragmentation" of chromosomes which appears in certain forms as a fixed hereditary property. J. L.

Bivalents in *Hyacinthus*.—JOHN BELLING ("Configurations of Bivalents of *Hyacinthus* with regard to Segmental Interchange." *Biol. Bull.*, 1927, 52, 480–87, 5 text-figs.). The four large bivalents of *Hyacinthus* show connections (nodes) which are not at the ends. It is assumed that these nodes represent places where two of the four chromatids have undergone segmental interchange by fracture and recombination. These large bivalents assume a variety of configurations, showing in 62 cases one node, and in 54 cases two nodes where the homologues cross. At these nodes it appears that one chromatid of each homologue passes obliquely across, while the other seems bent back along the other homologue. The numbers of cases of possible segmental interchange in the chromatids of the 116 bivalents examined, calculated from the numbers of nodes, agrees roughly with the numbers of cases of crossing-over found in the first chromosome of *Drosophila*. Segmental interchange is accepted as a working hypothesis to account for nodes and internodes of the chromosome pairs. J. L.

Nuclear and Systematic Differences in *Festuca*.—G. A. LEVITSKY and N. E. KUZMINA ("Karyological Investigations on the Systematics and Phylogenetics of the genus *Festuca*." Russian with English summary. *Bull. Appl. Botany, Genetics, etc.*, 1927, 17, 3–36, 6 pls.). The genus *Festuca* has proved very suitable for studying correlation between systematic and nuclear differences. The extreme polymorphism of some species is accompanied by sharp polyploid differences in chromosome number. Externally intermediate forms also are known, whose true nature can only be ascertained by cytological analysis. Karyotypical differences are also found within the limits of one variety. From the phylogenetic aspect those groups which are morphologically primitive are those with the smallest diploid chromosome number 14. The known tetraploid, hexaploid and decaploid forms have been evolved by the addition of sets of chromosomes. The primitive groups are those which are limited in geographical distribution, while the youngest group, represented by *F. ovina*, is widely spread and rich in forms with polyploid chromosome numbers. The distribution of this genus is thus in direct contradiction to the "age and area" hypothesis of Willis. J. L.

Reduction Divisions in a Charophyte.—ALBERT HENRY TUTTLE ("The Location of the Reduction Divisions in a Charophyte," *University of California Publications in Botany*, 1926, 13, 227-34, 2 pls.). A detailed description of the plant under discussion, with diagnoses of the new genus and species that it represents, are now in preparation for publication. The present paper describes lucidly the reduction divisions taking place in the apical cell of the antheridium and oogonium, the haploid cells of the resulting quadrants and all cells derived from them containing 16 chromosomes. The plant body is thus diploid, and the position of meiosis in the life-cycle would correspond with that in *Fucus*. J. L.

Cell Disjunction in Spirogyra.—FRANCIS E. LLOYD ("Cell Disjunction in Spirogyra," *Papers of Michigan Academy of Science*, 1926, 6, 275-87, 1 pl., 1 text-fig.). Two types of cell-disjunction are found in *Spirogyra*. Firstly, a mechanical process occurring in the thin-walled species and studied by means of motion photo-micrography in *S. Weberi*; secondly, a process involving hydrolysis of the cell-wall and consequent liberation of H pieces, typical of the thick-walled species and described for *S. nitida*. The mechanical process is dependent on loss of turgor of the abjected cell. The hydrolytic process starts in the outermost layers of the cell-wall, progressing inwards to the protoplasmic membrane. Abjection in *Spirogyra* appears to be the same process as occurs in the mosses.

J. L.

Enzymatic Function of Mitochondria.—E. S. HORNING and A. H. K. PETRIE ("The Enzymatic Function of Mitochondria in the Germination of Cereals," *Proc. Roy. Soc.*, 1927, B. 102, 188-206, 6 pls.). Mitochondria are found in moderate numbers in the scutellum and occasionally in the endosperm of the resting maize grain. During germination they become more numerous in the scutellum and large numbers are secreted from the epithelial cells into the adjacent starch-containing cells of the endosperm. The secreted mitochondria then aggregate round the starch grains prior to corrosion of the latter; as corrosion sets in, the associated mitochondria disappear. These processes continue throughout the whole period of endosperm depletion. The mitochondria originally present in the endosperm are able to increase by fission during germination, but are not so numerous as those secreted from the scutellum. This behaviour of the mitochondria lends considerable support to the enzymatic conception of mitochondrial activity, the supposition being that the starch-splitting enzyme is located within them at their surface, and is liberated from them when the mitochondria reach the surface of the starch grains. There does not appear to be any secretion of mitochondria from the aleurone layer, nor does depletion of the endosperm appear to be in any way affected by the secretion of enzymes from that layer. Similar mitochondrial behaviour is observed in germinating wheat and barley.

J. L.

Anatomy and Histology.

Primary Resin Canals in the Coniferæ.—C. S. HANES ("Resin Canals in Seedling Conifers," *Journ. Linn. Soc.*, 1927, 47, 613-36, 1 pl., 20 figs.). An account of the primary resin-canals of conifers, as distinct from canals occurring in tissues of cambial origin. It is found that seedlings of the same species show the same general distribution of primary resin-canals with only minor individual variations. Different species of the same genus are often very different in canal distribution, especially in the case of cotyledonary canals. The Abietinæ show a wide variation in the distribution of resin-canals. In the 31 species examined the cotyledons of 17 have no resin-canals, 11 have corner canals, and 3 (*Pinus*) have upward

extensions of the root-pole canals. Resin-canals appear to be entirely lacking in the cotyledons of the Cupressineæ. In the Taxodineæ no two species have a similar distribution. It is concluded that the number and distribution of primary resin-canals cannot be used as a criterion of relationship even between genera of Coniferæ, since these characters are often very different in species of the same genus. The resin-canals are formed as intercellular spaces (except in *Araucaria*) and not by the breaking down of cells. It is suggested that the actual pressure of the fluid resin may play an important part in the development of the lumen. Wounding has no positive effect on the production of primary resin-canals. B. J. R.

Bracts of *Anemone*.—A. EVELYN CHESTERS ("The Vascular Supply of the Bracts of some Species of *Anemone*," *Journ. Linn. Soc.*, 1927, 47, 553-82, 16 pls., 9 figs.). The form and position of the bracts of various species of *Anemone* are described, and these are compared with the bracts of *Eranthis hyemalis* and with the sepals of *Ranunculus Ficaria*. A detailed account is given of the vascular supply of the bracts of various species of *Anemone* and of the part played by the bract bundles on entering the axis. It is found that the difference in the form and position of the bracts is accompanied by well-defined anatomical variations, certain of these variations in the vascular anatomy being directly correlated with the form and function of the bracts. Where no definite involucre is formed, there is little fusion between the bract-bundles, and on entering the axis ring only the midrib forms a main bundle. Species with an involucre of sessile bracts with reduced lamina and broad base show a tendency to parallel venation, an increase in the number of bract-bundles and lack of fusion between lateral and marginal, but the vascular system of the axis is still dominated by that of the involucre. The vascular anatomy of the bracts and the bract-node of these species of *Anemone* appears to support the view of the homology of the involucre of *A. Hepatica* and the calyx of *Ranunculus Ficaria*. A similar resemblance exists between the bracts of *Eranthis hyemalis* and those of *A. nemorosa*. B. J. R.

Century-old Living Cells.—D. T. MACDOUGAL and F. L. LONG ("Characters of Cells attaining Great Age," *Amer. Naturalist*, 1927, 61, 385-406). Certain massive cacti whose shoots are reduced to columnar form include tracts of tissue in which the living cells may attain a great age. The extension of the life of a cell over a long period affords opportunity for studying the changes which take place in the composition of living matter and the factors which make continued existence of protoplasm possible. In the Barrel cactus, *Ferocactus Wislizenii* (*Echinocactus Wislizenii*), cells of the medulla and cortex have been found to live for over a hundred years. A rapid enlargement takes place in both cortex and medulla during the first ten years of development. Medullary cells subsequently undergo some deformation but no measurable change in volume. The cross-sectional area of the cortical cells is doubled in the following century, consequent upon a slow growth maintained over this period. Neither tissue retains meristematic capacity during the extended life period. A decrease in the carbohydrate content is accompanied by an increase in the number of crystals and insoluble inclusions. Permeability of the cell-membrane increases with age. B. J. R.

Living Cells in Heartwood.—D. T. MACDOUGAL and G. M. SMITH ("Long-lived Cells of the Redwood," *Science*, 1927, 66, 456-7). In the course of a study of the hydrostatics of *Sequoia sempervirens* it was found desirable to examine the parenchymatous cells of the wood. These are of two kinds, vertical parenchyma and ray-parenchyma. As in most other woody stems, the parenchyma-cells of the

sapwood are living and densely packed with starch. The change from sapwood to heartwood is recognisable by a brownish-red colouration of the heartwood, generally accompanied by a disappearance of starch and protoplasts from the parenchyma-cells and the formation of a resin that more or less fills the cell-lumen. In the ray-parenchyma cells the disappearance of starch is not always followed by death and disintegration of the protoplasts. Ray-cells seventy layers deep in the heartwood, i.e. nearly a century old, have been observed with clearly defined protoplasts and apparently normal nuclei. The authors believe this to be the first announcement of living cells in heartwood.

B. J. R.

Anatomy of *Zygophyllum Fabago*.—L. M. CUNNINGHAM ("Observations on the Structure of *Zygophyllum Fabago* Linn.," *Trans. and Proc. Bot. Soc., Edinburgh*, 1927, 29, 352-61, 3 figs.). The article includes an account of the general morphology of the species and the internal anatomy of the stem and leaf. Strands of wood-fibres run throughout the length of the internodes; the node itself is strengthened by stone-cells. The vascular system of the internode takes the form of a complete cylinder of xylem surrounded by phloëm. The cylinder is flattened on one side, corresponding with the configuration of the young stem, and on that side is not so well developed as on the convex side. The central cylinder breaks up at the node into eight portions, two of which constitute a direct petiolar supply, two form a girdle system supplying the stipules and connecting with the petiolar strands, and the remaining four join up to form the cylinder of the next node. The floral structure is described.

B. J. R.

The Anomalous Root Structure of *Mesembryanthemum*.—CHRISSEY I. KEAN ("Anatomy of the genus *Mesembryanthemum*. I.—Root Structure," *Trans. and Proc. Bot. Soc., Edinburgh*, 1927, 29, 381-88, 3 pls.). Examination of 57 species shows that anomalous stelar structure characterises the roots of all the *Mesembryanthema*. The author describes four distinct types which are linked together by various characters. There are in addition several intermediate types. Anomalous thickening is brought about by a secondary cambial zone which arises in the external layer of the phloëm, and after functioning for a short time is replaced by a third, which may be succeeded by a fourth and even a fifth. At intervals small areas of the parenchyma between the rings so formed become lignified and form bridges linking up the various zones of lignified tissue. The xylem-rings are broken at intervals by outgoing branch-roots.

B. J. R.

Laticiferous Elements in the Outer Bark of the Para Rubber Tree. —E. QUISUMBING ("The Occurrence of Laticiferous Vessels in the Mature Bark of *Hevea brasiliensis*," *Univ. Calif. Publ. Bot.*, 1927, 13, 319-32, 4 pls.). The author announces the occurrence of laticiferous vessels outside as well as inside the stone-ring of the Para rubber-tree. No latex-tubes are found in the secondary wood, with the exception of some in the medullary rays. In the bark laticiferous vessels are abundant in the inner bast. Some are found in the outer bast and in the region outside the stone ring, but they do not branch so freely as those in the inner bast. In the mature bark latex-tubes may have two origins, one of cambial origin in the secondary cortex, within the stone-ring, the other of peripheral origin, outside the stone-ring, coming from the primary cortex and phellogen.

B. J. R.

Calcium Carbonate Deposits in Woods. —S. J. RECORD ("Occurrence of Calcium Carbonate Deposits in Woods," *Trop. Woods*, 1927, 12, 22-26). Deposits of calcium carbonate are of very common occurrence in the vessels and sometimes in other cells of traumatic and abnormal wood of many widely separated families.

Such deposits have little or no diagnostic value. Similar deposits in the sapwood and normal heartwood are rare and may have important diagnostic value. Cystoliths of calcium carbonate characterise the woods of the Opiliaceæ and are not known to occur in any other woods. A list of species, belonging to 28 families, in whose woods calcium carbonate deposits have been observed, is appended.

B. J. R.

Wood Structure of the Juglandaceæ.—D. A. KRIBS ("Comparative Anatomy of the Woods of the Juglandaceæ," *Trop. Woods*, 1927, 12, 16-21). Anatomical features common to the woods of the walnut family are fine concentric lines of parenchyma, narrow rays, comparative scarcity of pores, small bordered pits to the fibres and crystals in the rays and wood-parenchyma. Study of the wood-structure indicates that there are two general divisions, the *Carya* type and the *Juglans* type. Only four distinct genera are recognised, namely, *Carya*, *Platycarya*, *Juglans* and *Engelhardtia*. *Pterocarya* belongs to the division of *Juglans*, and *Alfaroa* to the *Oreomunnea* section of *Engelhardtia*.

B. J. R.

Wood-Structure of the Lauraceæ.—W. W. TUPPER ("A Comparative Study of Lauraceous Woods," *Amer. Journ. Bot.* 1927, 14, 520-24, 3 pls.). The author examined the wood of 15 genera and more than 50 species. In nearly all the woods examined the vessels had mostly porous end-walls instead of the scalariform type which was considered by earlier investigators to be the more characteristic. Wide variation was found in the type of vessel-pits, the wood-parenchyma, the fibres, and the size of the rays. The presence of prominent marginal ray-cells, which often develop into secretory cells, seemed to be the only constant family character. These specialised cells are found also in several other families. In the Apocynaceæ and the Araliaceæ they are large and well-developed. In the Annonaceæ they are small. In the Rubiaceæ they are long and wing-like, while in the Burseraceæ they are noticeably abundant. In other families such as the Bignoniaceæ, Combretaceæ, Elæocarpaceæ, Euphorbiaceæ, Guttiferæ and Pittosporaceæ, and in certain representatives of the Leguminosæ and Cornaceæ these marginal ray-cells are characteristically present and are often very similar to those of the Lauraceæ. The author concludes that it is safer to refer fossil woods to existing genera in the Lauraceæ rather than to the whole family since the latter varies so widely. He is convinced that many of the fossil woods described as *Lauroxylon* come from entirely different and widely separated families.

B. J. R.

Physiology.

Digestion in Carnivorous Plants.—A. QUINTANILLIA ("O Problema das Plantas Carnívoras. Estudo citofisiológico da digestão no *Drosophyllum lusitanicum*," *Bol. Soc. Broter.*, Coimbra, 1927, 4, 44-129, 1 pl.). A study of the physiology and cytology of *Drosophyllum lusitanicum*. This plant is able to utilise the albuminoids of animals owing to the active secretory power of its glands, which produce a ferment similar to pepsin; this ferment brings about a solution of the albumen compounds when in an acid medium. Two kinds of glands are present, each with its own definite function. One type is stalked and secretes a viscous fluid which attracts and holds insects, at the same time stimulating the second type, which is concerned solely with digestion. Under certain conditions the stalked glands are also able to absorb albumen compounds without any help from the true digestive glands, and more rarely the latter can complete the work of digestion independently of the trapping glands. The stimulation of the digestive glands is mainly due to the chemical action induced by the liquid secreted by the trapping

glands. The actual mechanism of the stimulus imparted by one set of glands to the other is not clearly understood, but vascular bundles are believed to be concerned in the process. The power of the digestive glands diminishes after fertilisation. The black concretions which are found on the trapping glands are intravacuolate precipitates of anthocyanin. The concretions on the digestive glands are due to the melanin of the absorbed albumen. The chondriome of the glandular cells has a very small share in the work of elaboration of the digestive ferment, although in the secretive layer both the chondriome and the chondriocentes are considerably reduced in volume during the secretive process. The vacuome is the seat of secretion, and plays an important part both in secretion and digestion. There appears to be no explanation of the lack of mineral nutrition in *Drosophyllum*; all that can be stated with certainty is that the animal food compensates for the deficiency.

S. G.

CRYPTOGAMS.

Pteridophyta.

Anatomy of *Ophioglossum*.—BHAGAT RAM VASISHT ("The Comparative Anatomy of *Ophioglossum Aitchisoni* d'Almeida and *Ophioglossum vulgatum* L.," *Journ. Indian Bot. Soc.*, 1927, 6, 8-30, 12 pls.). A comparative account of the characters of two species of *Ophioglossum* found in India, with reference to their habit, morphology and anatomy. *O. Aitchisoni* bears more leaves, has a rhizome elongated and covered with persistent sheaths, has a linear-lanceolate and acute lamina, with the spike inserted a little above the base of the lamina, and with stomata almost confined to the lower surface of the lamina. Internally it is distinguished from *O. vulgatum* by the presence of scattered tracheids in the pith, the origin of the xylem strands in the parenchyma of the openings, the separation of the xylem strand from one margin of the gap and its fusion with the other margin of the same gap, the separation of bundles from the main stele that disappear in their course through the cortex; further, the leaf-trace is double, the bundles of the peduncle are arranged almost in a straight line, and the root-steles may be diarch, triarch or tetrarch.

A. G.

Bryophyta.

Pyrenoids of *Anthoceros*.—F. McALLISTER ("The Pyrenoids of *Anthoceros* and *Notothylas* with especial reference to their Presence in Spore Mother-Cells," *Amer. Journ. Bot.*, 1927, 14, 246-57, 2 pls.). Pursuing his study of the pyrenoids of *Anthoceros* and *Notothylas*, the author has come to the following conclusions. Cells of *Notothylas*, if favourably situated for photosynthesis, all contain multiple pyrenoids in the plastids both of gametophyte and sporophyte. These pyrenoids are made up of from twenty to several hundred safranin-staining bodies, spindle-shaped in active cells, rather rounded in dormant cells; and these are transformed into rudimentary starch grains without change of form or position. In deeper-lying plastids the red-staining bodies are not aggregated into a definite pyrenoid. The plastids of cells of the sporogenous layer contain scattered pyrenoid bodies both in *Notothylas* and *Anthoceros*. With the differentiation of the spore mother-cells of *Anthoceros* and *Notothylas* the plastids of these cells undergo extensive vacuolation, resulting in the formation of a large vacuole-like structure which occupies the position previously held by the more compact plastid. During this

process of vacuolation the pyrenoid bodies cannot be recognised at first, but become clearly visible towards the end. They are transformed into rudimentary starch grains as is the case in the pyrenoids of the assimilative cells. A. G.

Chromosomes of *Sphaerocarpos*.—ALFRED M. WOLFSON ("The Chromosomes of *Sphaerocarpos texanus*," *Amer. Journ. Bot.*, 1927, 14, 516-19, 1 fig.). The material of *Sphaerocarpos* studied was collected near Brussels and was determined to be *S. texanus*. The object was to find out whether the chromosomes agreed with those of *S. texanus* from America. Satisfactory chromosome figures could only be observed in the gametophytes, at the growing points of female thalli, in developing archegonia and involucre, and in the developing antheridia of the males. It was found that the number of chromosomes in the European plant is eight (as in the American plant); in the female gametophyte one of the chromosomes (X-chromosome) is very large, while in the male there is a corresponding small one (Y-chromosome). In the X-chromosome there is a clear, non-stainable area which is described. A. G.

***Preissia*.**—SISTER MARY ELLEN O'HANLON ("A Study of *Preissia quadrata*," *Bot. Gaz.*, 1927, 84, 208-18, 15 figs.). The result of this study is as follows. In each female receptacle 12-16 archegonia are borne, usually three or four in each quadrant. After fertilisation, usually about four mature sporophytes are developed in a single receptacle. The cells from which the elaters arise appear to be sister-cells to the spore mother-cells; therefore the spores are four times as numerous as the elaters. The number of spores in each capsule is estimated at about 3,000. The spores, though much fewer than in *Marchantia*, are four times as wide; and the elaters of *Preissia* are smaller than those of *Marchantia*, but more in number. The spores of *Preissia* germinate readily on a solid substratum, but retain their vitality for a shorter time than do *Marchantia* spores. Spore germination is much as in *Marchantia*, but more variable. Branching is common; sometimes two thalli arise from a single spore cell. There are no cells for the storage of essential oils in the young thallus of *Preissia*; the rhizoids, relatively few, are of the plain walled type as in *Marchantia*. There being no midrib in adult *Preissia*, the thickening in the young plant is more diffused than in *Marchantia*. The young gametophyte of *Preissia* has many active growing points, and its contour is therefore irregular. A distinct apex of marginal meristem is conspicuous in at least one region of the young thallus. As in *Marchantia*, there is no single cell that can be designated as the apical cell. A. G.

***Metzgeria*.**—G. CHALAUD et G. NICOLAS ("La croissance terminale et la 'fausse dichotomie' de *Metzgeria furcata* Dum.," *Bull. Soc. Bot. France*, 1927, 74, 113-30, 1 pl.). A study of the apical growth in *Metzgeria furcata*. The apical cell is two-sided and gives birth to lateral segments, which each become divided into a marginal and a deeper cell, from which respectively arise the lamina and the nerve of the frond. In the deeper cell two transverse walls parallel to the surface of the frond cut off (1) a dorsal and a ventral cell from which originate the dorsal and ventral superficial layers of the nerve; (2) a median cell the origin of the central differentiated tissue of the nerve. The marginal cell above-mentioned forms the wings of the lamina by a series of intercalary divisions perpendicular to the surface of the frond. Sometimes in one of the marginal cells is produced a young initial, from which is developed a lateral branch, which either can be distinguished from the main branch by its more feeble growth, or attains dimensions indistinguishable from those of the main branch, and gives the appearance of a dichotomy. A. G.

Hepaticæ of Montpellier.—MARGUERITE DUGAS ("Observations sur les Hépatiques des environs de Montpellier," *Bull. Soc. Bot. France*, 1927, 74, 107–112). A study of the hepatic flora of Montpellier and of the ecological conditions that restrict it. In all, 26 species were collected, comprising 10 Ricciaceæ, 4 Marchantiaceæ, and 12 Jungermanniaceæ. The predominance of thalline forms, especially *Riccia*, and the scarcity of epiphytic, aquatic and small foliose species, is characteristic of the Mediterranean climate and the porous calcareous soil. The results contrast with those obtained by Chalaud at Toulouse, where the total of species is 40, the foliose forms are more abundant and the Ricciaceæ few, the conditions being less dry. The male and female inflorescences and fruit of *Lunularia vulgaris* are rarely found, and a list is given of the few places in France where they have respectively been noted. A. G.

British Sphagna.—WILLIAM ROBERT SHERRIN ("An Illustrated Handbook of the British Sphagna (after Warnstorf).") London: Taylor & Francis, 1927, i–x, 1–74, 8 pls. and figs.). A synopsis of the Sphagnaceæ of the British Isles, with keys to the sections, species and varieties, with descriptions translated from Warnstorf's "Sphagnologia universalis" (1911), and figures. The question of distribution is omitted, as the facts are readily accessible in the Census Catalogue of British Mosses published by the British Bryological Society in 1926. The number of species recorded for our islands is 48. The number of varieties of many species is large, but colour varieties, forms and subforms are excluded. A. G.

Sphagna of France.—G. DISMIER ("Flore des sphaignes de France," *Archiv. Botan.*, 1927, Tome 1, Mémoire No. 1, 1–64, 39 figs.). A practical account of the Sphagnaceæ of France, consisting of keys to the sections and species, illustrations, concise descriptions of the species, and distribution of the plants in France. Only a limited number of varieties are included. The second part of the memoir is an essay on the geographical distribution of the genus in France. The country is divided in three zones—plains, sub-alps, mountain chains—and by means of 17 tables the distribution of the species in the various departments or sub-departments is clearly shown. In all, there are 36 species recorded for France. A. G.

Maireola, a New Moss.—I. THÉRIOT ("Un nouveau genre de mousses: Maireola (Dicranaceæ)," *Archiv. Botan.*, 1927, 1, 47, 48, 1 fig.). *Mairelola atlantica* Thér. et Trab. is a new genus and species collected on the Atlas Mountains of Morocco at an altitude of 11,500 feet. Its affinities are with *Campylopus* and *Dicranella*. From the latter it is distinguished by its short conical operculum, by the peristome, and the structure of the nerve, and from *Campylopus* by the autoicous inflorescence, the erect pedicel, and the peristome teeth. A. G.

Phasconica.—R. POTIER DE LA VARDE ("A propos de *Phasconica Balansa* C.M.," *Archiv. Botan.*, 1927, 1, 39, 40). The rare moss *Phasconica Balansa* was described by C. Müller in 1883 as from New Caledonia; but this place of origin has not been free from suspicion, as the only other species of *Phasconica* was gathered in Uruguay, and Balansa made his collections both in New Caledonia and in Paraguay. Collectors in New Caledonia have been urged to keep a sharp look-out for the moss; but it is only now that proof is forthcoming that New Caledonia is indeed the home of the species; it has been detected in some tufts of *Nanomitrium Brotheri* Paris gathered by Le Rat in 1908. A. G.

Hookeriopsis.—R. POTIER DE LA VARDE (“*Hookeriopsis Mittenii* nom. mutat.,” *Archiv. Botan.*, 1927, 1, 138, 139). A discussion of two species of *Hookeriopsis* bearing the same name, *H. versicolor*. One, named *Hookeria versicolor*, by Schimper, came from Guadeloupe, and was described by Bescherelle in 1876. The other, described as *Lepidopilum versicolor* by Mitten in 1863, came from West Africa. Both species are now included in *Hookeriopsis*, but in different subgenera. The younger species, from Guadeloupe, was transferred to *Hookeriopsis* by Jaeger and Sauerbeck in 1876; but Mitten’s species was not placed in *Hookeriopsis* until 1913, in a paper by Brotherus. Both species stand under *Hookeriopsis* in Brotherus’s *Musci* monograph (*Nat. Pflanzenfamilien*, Edition II). Potier de la Varde alters the name of Mitten’s species to *Hookeriopsis Mittenii*, in accordance with article 53 of the International Rules of Botanical Nomenclature. A. G.

Hypnum triquetrum.—LUCIEN PLANTEFOL (“Étude biologique de l’*Hypnum triquetrum*. Relations entre la morphologie, la physiologie et l’écologie d’une espèce végétale,” *Ann. Sci. Nat. Bot.*, 1927, 10^e sér., 9, 1–269, 2 pls., 32 figs.). An intensive study of *Hypnum triquetrum* in relation to the effect produced upon its morphology by changes in its environment—the variations of ramification, stem, foliage, leaf, areolation; the physiological aspect, the relation between the water-content of the moss and the chemical constitution of the water in which any particular growth form flourishes; atmospheric influences and effects; respiration and assimilation; the ecology and distribution of the species. A. G.

Mosses of the Iberian Peninsula.—A. LUISIER (“*Musci Salmanticenses. Descriptio et Distributio Specierum hactenus in Provincia geographica Salmanticensi Cognitarum. Brevi addito conspectu Muscorum totius Peninsulae Ibericæ*,” *Mem. Real Acad. Ciencias, Madrid*, 1924, ser. 2, 3, 1–280). In this memoir 86 genera and 184 species are credited to the moss flora of Salamanca, including 3 endemic species and a few rarities. There is also a conspectus of all the mosses known to occur in Spain and Portugal. A. G.

African Mosses.—R. POTIER DE LA VARDE (“*Mousses nouvelles de l’Afrique tropicale française. Diagnoses préliminaires*,” *Bull. Soc. Bot. France*, 1927, 74, 142–153, 8 figs.). A continuation of the author’s notices of new mosses from French west tropical Africa. The present chapter contains descriptions and figures of eight species from Gaboon, with notes on their peculiarities and affinities. A. G.

Mosses of South India.—H. N. DIXON et R. POTIER DE LA VARDE (“*Contribution à la flore bryologique de l’Inde méridionale*,” *Archiv. Botan.*, 1927, 1, 161–84, 7 pls., 3 figs.). An account of the moss collections made by Rev. P. Foreau and others in South India, on the Pulney Hills and the vicinity of Madura, Mangalore, and Madras. The first part of the paper consists of descriptions of 38 new species and of a new genus of Sematophyllaceæ, *Foreauella*, which is frequently gathered but usually without fruit. The second part is an enumeration of 60 species with distribution and notes. Among these are species already recorded for Ceylon, and some which were previously known in Java only. A. G.

New Mosses.—I. THÉRIOT (“*Deux mousses nouvelles*,” *Archiv. Botan.*, 1927, 1, 66–69, 2 figs.). Descriptions of two new species found by J. Cardot in the Paris Museum: (1) a *Fontinalis* from Utah, N. America, collected by J. Remy in 1855; (2) *Lyellia platycarpa* from Yunnan. The latter was referred by Bescherelle to *Lyellia crispa* R.Br., but is distinguished by having its capsule remarkably compressed—a condition which Bescherelle attributed to accident. A. G.

Thallophyta.

Algæ.

Diatoms.—F. B. TAYLOR ("Diatoms," *Bournemouth Nat. Sci. Soc.*, 1927, 19, 1-9). An account of the diatoms—their structure, life-requirements, reproduction, distribution, vast geological deposits, history, movements, superficial sculpture, classification, economic uses. Reproduction is effected (1) by longitudinal self-division; (2) by auxospore formation; (3) by microspores in certain genera; (4) by rest-spores or statoblasts in a few genera; (5) by formation of miniature frustules within the parent cell. The earliest published figure of a diatom was in "Philosophical Transactions," 1703, a *Tabellaria*. Diatoms of navicloid form have a slow movement in the direction of their long axis, due to some unexplained mechanism in the rhabdium. The study of the exquisite sculpture markings of diatom frustules sixty years ago was mainly responsible for the striking development of microscopes. The uses of diatoms are notable; they provide a fundamental food supply in the ocean to small crustaceans and other low animal forms which are fed upon by fishes. In industry they are used in the manufacture of polishes, porcelain, light artificial stone, dynamite, erasers, non-conducting fire-bricks, etc.

A. G.

Variation in Cocconeis.—ORVILLE TURNER WILSON ("Asymmetrical variation in *Cocconeis scutellum*," *Amer. Jour. Bot.*, 1927, 14, 267-73, 1 pl.). Asymmetrical variation in diatom species which are typically symmetrical has received little attention from diatomists; there has been a tendency to regard such variation as due to environmental factors or to individual weakness resulting in deformity. The author made observations of the asymmetrical variation in *Cocconeis scutellum* and found a uniformity and vigour of individuals in certain types such as to indicate hereditary factors as a more logical explanation, since the environment was the same both for the symmetrical type species under observation and for the asymmetrical variants of the same. The method of observation was as follows. Sixty glass plates were suspended on frames in the ocean off the Californian coast; 30 were suspended just below the surface, and 30 at a depth of 10 feet. One plate was removed daily for each of the two sets and examined microscopically. Thus 60 cultures progressing in age during a month were obtained and photographed. The numbers of *Cocconeis scutellum* on the plates increased rapidly and formed almost a complete crust by the end of the month. This increase was due mostly to multiplication of the diatoms that settled early on the slides, and only partly to the new arrivals as the days went on. A bibliography of papers is added.

A. G.

Trachelomonas.—GEORGES DEFLANDRE ("Remarques sur la systématique du genre *Trachelomonas* Ehr.," *Bull. Soc. Bot. France*, 1927, 74, 285-88). The author published a monograph of the genus *Trachelomonas* in 1926, and has collected material for a supplement which will contain descriptions and figures of new species or omissions. Meanwhile he publishes a preliminary notice in which 25 corrections or changes of name are recorded, and a bibliography is appended.

A. G.

Phytoplankton of Norfolk Broads.—BENJAMIN MILLARD GRIFFITH ("Studies in the Phytoplankton of the Lowland Waters of Great Britain. No. V. The Phytoplankton of some Norfolk Broads," *Journ. Linn. Soc. (Bot.)*, 1927, 47, 595-612, 11 text-figs.). The history of how the Broads came into existence is explained. They are divided into three groups, and the plankton flora is recorded for each of the Broads examined, local conditions being noted. The

distribution of the algal flora is then discussed in relation to the ecological factors, and the relative abundance or scarcity or absence of each species in the several Broads is shown in a table. The notes on some of the species are illustrated with figures, and a bibliography is supplied. A. G.

Algæ of Lake of Geneva.—R. CHODAT ("Sur l'apparition subite de deux algues vertes nouvelles dans le plancton du lac de Genève," *C. R. Soc. Phys. et d'Hist. Nat. de Genève*, 1927, 44, 66-67). The plankton flora of the lake has been remarkably constant for thirty years, especially as regards the Chlorophyceæ. The following are always present: *Sphærocystis Schroeteri*, *Oocystis lacustris*, *Nephrocystium Agardhianum*, *Closterium Norstedtii*, *Ankistrodesmus lacustris*, *Botryococcus Braunii*. In 1927 two new algæ appeared in the plankton, one being a *Pandorina* (allied to *P. charkowiensis* Korsch., but differing in the cilia and their setting) which was found in every sample; and the other a *Willea*, which much resembles *W. irregularis* R. and F. Chodat. A. G.

Carotin in Algæ.—R. CHODAT and FL. MAYER ("Sur les conditions de la formation de la carotine chez les algues en culture pure," *C. R. Soc. Phys. et d'Hist. Nat. de Genève*, 1927, 44, 107-10). An account of some culture experiments made with *Hæmatococcus pluvialis*, 3 spp. of *Scenedesmus*, and a *Chlorella*, to determine the conditions of the formation of carotin in these algæ. It was found that carotin is formed with much greater intensity when the culture medium is poor in assimilable nitrogen. A. G.

Ankistrodesmus.—ELIZABETH KOL ("Über ein neues Mitglied des Kryo-planktons der Hohen Tatra, *Ankistrodesmus tatrae* Kol nova species," *Acta Soc. Botanicorum Poloniae*, 1927, 4, 166-68, 1 pl.). A description of *Ankistrodesmus tatrae*, a new species gathered in quantity on a glacier on the northern side of Hohe Tatra in September 1926. It belongs to the section *Raphidium*, and differs from the two glacier-dwelling species *A. nivale* and *A. Vireti* in shape, size, chloroplasts, and gelatinous envelope. A. G.

Calothrix.—P. FRÉMY ("Une rivulariacée nouvelle *Calothrix Flahaulti*," *Archiv. Botan.*, 1927, 1, 5-8, 1 fig.). A description of a new species of *Calothrix* found in a bog pool in the Landes de Lessay, Manche, in April 1924. It is distinguished from all other freshwater species by the perfectly cylindric form of its filaments and trichomes. It occurred in association with *Utricularia*, *Nitella*, and some 60 algæ, a classified list of which is given. A. G.

New Stigonemaceous Alga.—P. FRÉMY ("Une stigonémacée nouvelle: *Hyphomorpha Perrieri*," *Archiv. Botan.*, 1927, 1, 63-66, 2 figs.). A description of a new species of *Hyphomorpha*, a stigonemaceous genus, of which only one species was previously known, namely, *H. antillarum* Borzi, found on hepatics in the West Indies. The new species grew on the bark of *Melia Azedarach* in Madagascar. It is a dichotomously branched filiform plant, propagated by chroococcoidal gonidia. The distinguishing characters of the two species are set forth in a table. A. G.

Entophysalis.—NATHANIEL LYON GARDNER ("A new species of *Entophysalis* from China, and notes on other species of the genus," *Univ. Cal. Pub. Bot.*, 1927, 13, 369-72, 1 pl.). Description of *Entophysalis zonata*, a new species of blue-green algæ found on rocks by a mountain brook near Foochow. Other species are known from Samoa, Malaya, and Porto Rico, but there is much doubt about the species recorded for the United States. A. G.

Myxophyceæ of South India.—P. FRÉMY ("Petite contribution à la flore des myxophycées de l'Inde méridionale," *Archiv. Botan.*, 1927, 1, 46, 47.) A list of nine blue-green algæ found on mosses collected in Madura by Rev. P. Foreau. There are five species of *Scytonema* and one each of four other genera. A. G.

Myxophyceæ of Rangoon.—S. L. GHOSE ("The sub-aerial Blue-Green Algæ of Rangoon," *Journ. Indian Bot. Soc.*, 1927, 6, 79–84.) The sub-aerial blue green algæ of Rangoon are found on damp soil, trees, buildings, palings, sides of drains, and the rainy season is between May and October. Purely aquatic forms are rare in Rangoon, and most of the sub-aerial species are without spores. During the dry months the filaments remain dormant inside a thickened coloured sheath, or simply dry up and revive when again soaked. Nineteen species, belonging to thirteen genera, are here recorded. A. G.

Acrochætium and Rhodochorton.—GONTRAN HAMEL ("Recherches sur les genres *Acrochætium* Naeg. et *Rhodochorton* Naeg.," 1927. Saint-Lo : Jacqueline. 1–117, 34 figs.). A monograph of *Acrochætium* and *Rhodochorton* with a preliminary chapter on the synonymy of the Chantransiæ. *Acrochætium* is represented on the coasts of France by 22 species; a key to these is provided, and descriptive or critical notes of each species are given, usually with a figure. They are divided into three groups, according as the base of the plant is unicellular, endophytic, or multicellular. *Rhodochorton* is represented by six French species, and is treated in like fashion. Chapter IV analyses several confused species of *Acrochæte* and refers them to their proper systematic positions, and also discusses nine exotic species. Chapter V is a classified enumeration of 100 species of the whole world, and Chapter VI contains a similar enumeration of 17 species of *Rhodochorton*, and is followed by a bibliography. A. G.

New Rhodophyceæ from California.—NATHANIEL LYON GARDNER ("New Rhodophyceæ from the Pacific Coast of North America, II, III," 1927, *Univ. Cal. Pub. Bot.*, 13, No. 13, 235–72, 12 pls.; No. 16, 333–68, 13 pls.). No. 13 contains descriptions of 12 new species of red algæ and a variety with critical notes. The genera concerned are *Bangia*, *Erythrotrichia* (5 species and a variety), *Cryptopleura*, *Hymenaea*, *Gymnogongrus*. Three new combinations and a new specific name are also created. No. 16 has descriptions of 9 new species and a new genus (*Gelidiocolax*), also a new generic name—*Asymmetria*—to replace *Coriophyllum*, the latter having been previously employed for a genus of phanerogams. A. G.

Gelidium in California.—NATHANIEL LYON GARDNER ("New Species of *Gelidium* on the Pacific Coast of North America," *Univ. Cal. Pub. Bot.*, 1927, 13, No. 14, 273–318, 19 pls.). Descriptions of 10 new species and a variety of *Gelidium* collected on the coast of California, with critical notes. A. G.

Spores of Nematiceæ.—E. CHERMIN ("Sur le développement des spores chez quelques némalées," *Bull. Soc. Bot. France*, 1927, 74, 163–67, 2 figs.). The spore germination of *Helminthocladium* recalls that of *Nemalion*, being of the filamentous type with Chantransioid preformation. But as regards *Helminthora* the behaviour is quite different; the spore retains some contents, the germinal tube is short and soon buds and forms a discoid mass from which the frond arises. *Helminthora*, therefore, is of Kylin's filamentous type without Chantransioid formation, the frond arising from a cellular disc. It much resembles *Dudresnaya coccinea* in germination. We have, then, on the one hand, germinations strictly filamentous, issuing from a spore which empties itself in *Nemalion*, *Helminthocladia*, *Scinaia*

Colaconema, etc., and, on the other hand, germinations scarcely filamentous, ramifying into a disc, the spore not emptying itself, as in *Helminthora*, *Dudresnaya*, etc. A. G.

Spores of *Naccaria* and *Atractophora*.—E. CHEMIN ("Sur le développement des spores de *Naccaria Wiggii* Endl. et *Atractophora hypnoides* Crouan," *Bull. Soc. Bot. France*, 1927, 74, 272-77, 2 figs.). The development of the spores of *Naccaria* and *Atractophora* is of two kinds—the one filamentous, the other discoid. This, added to other differences, justifies the separation of these two algæ generically. Tetraspores have not been found in either species. The plants as we know them represent the haploid phase (gametophyte), and the diploid phase (sporophyte) is reduced to the formation of the zygote. A. G.

Fruiting of *Dictyota*.—W. D. HOYT ("The Periodic Fruiting of *Dictyota* and its Relation to the Environment," *Amer. Journ. Bot.*, 1927, 14, 592-619). All observed species of *Dictyota*, wherever studied, have been found to produce their sexual fruits at more or less regular periods. Three types of periodicity have been observed: (1) in Europe at each spring tide; (2) in North Carolina at the spring tides of the full moon; (3) in Jamaica at more prolonged intervals. The fruiting periods are in part related to the tide and to the range of the tide. But when the tides are altered by the wind, the alga still fruits at its regular time, and even in the laboratory it maintains its fruiting period. The eggs and sperms are mostly discharged within an hour, to the plant's great advantage, because fertilisation is thus facilitated. Non-sexual plants under the same conditions show no periodicity, but produce and discharge spores at any time. No single factor or group of factors will account for the periodicity; for, just as the form and structure of the alga have been developed in reaction to external conditions, so, too, has the fruiting habit; and this habit has been so developed as to synchronise with the rhythmic changes of external conditions. Yet the habit so acquired by the organism persists for months after the plants are removed from the rhythmic external conditions. Several other algæ produce their sexual cells periodically in relation to the tides, while others bear their fruits simultaneously but at irregular intervals. A number of animals are known to have a reproductive period related to the phases of the moon. Periodicity in the production of sexual cells may be much more common than is realised, and much study is needed to determine the controlling factors. A. G.

Fungi.

Note on *Pythium proliferum*.—C. W. WARDLAW ("Note on the Occurrence of *Pythium proliferum* de Bary on the Roots of the Strawberry," *Ann. Bot.*, 1927, 41, 817-8). The question has been debated as to whether this fungus is a saprophyte or a parasite. The roots of the strawberry on which it grew had been more or less water-logged and more or less weakened or damaged. The fungus appeared on the roots of the host in the laboratory, and was observed not only on dead but also on young living roots. By culture methods Wardlaw was able to observe the development of the fungus and to identify it fully with *P. proliferum*. A. L. S.

Infection Experiments with *Ligniera Junci*.—W. R. IVIMEY COOK ("The Influence of Environment on the Infection by *Ligniera Junci*," *Trans. Brit. Mycol. Soc.*, 1927, 12, 282-90). *Ligniera* attacks the roots of water plants, and was found in great abundance at Knole Park, Sevenoaks, Kent. It was proved, by observation and by experiment, that infection took place in many plants where they were

protected from light. Infected plants in which the roots were illuminated lost the fungus in less than three months. It is possible that the toxic substance may be chlorophyll. It was also proved that *Ligniera Junci* only infects plants in an acid soil and in solutions of pH5 to pH8 if at the same time the roots are protected from light.

A. L. S.

Study of Chondriosomes in Pilobolus.—HALINA LOPREŃSKA ("Badania nad chondriomen wakuolami i tłuszczami w ciągu rozwoju osobnikowego *Pilobolus crystallinus* Bref. Observations sur le chondriome, les vacuoles et les graisses au cours de l'ontogénie du *Pilobolus cristallinus* Bref.," *Acta Soc. Bot. Poloniae*, 1927, 4, 97-105, 1 pl. Polish with French résumé). The writer found abundant "chondriomes" in the vegetative as well as the sporiferous hyphæ and the developing sporangia. Vacuoles are filled with a colloidal solution of "metachromatine." Fat globules crowd the sporogenous plasma; they retain their form up to the formation of adult spores.

A. L. S.

Disease of Flies.—BESSIE GOLDSTEIN ("An Empusa Disease of Drosophila," *Mycologia*, 1927, 19, 97-109, 10 pls.). The disease has been noted for several years on wild fruit-flies in the neighbourhood of Columbia University. It has been studied by cultures and otherwise. Morphologically the fungus agrees with *Empusa muscæ*, the disease of the common house-fly. The physiological identity cannot be established with certainty until successful cross-inoculations have been made. The author has established the difference in the conidia from those of *Entomophthora* that had been previously noted, viz., the single nuclei of the latter, while *Empusa* conidia are multinucleate. The formation of the conidia was observed as the moving upwards of protoplasm from the conidiophore to a bud on the top. When all the contents have passed up, a septum cuts off the conidium from the empty conidiophore. Goldstein has given a synopsis of the genera of Entomophthoraceæ and a list of papers dealing with the family.

A. L. S.

Research of Mucorini.—W.-H. SCHOPFER ("Recherches sur la sexualité des mucorinées hétérothalliques," *Compt. Rend. Soc. Phys. Hist. Nat., Genève*, 1927, 44, 75-8). Schopfer has tested the reaction of the + and - mycelium of *Mucor hiemalis* to a toxic substance SO^4Cu in solutions of various strength. Spores were sown and the growth results recorded. In the majority of cases the two sexes reacted differently, the - mycelium growing more vigorously than the other. In other tests no real difference was noted.

A. L. S.

Formation of Zygotes in Mucorini.—W.-H. SCHOPFER ("Recherches sur l'influence du milieu nutritif sur la formation des zygotes chez les mucorinées hétérothalliques," tom. cit. 118-20). The experiments were again made with cultures of *Mucor hiemalis*. Schopfer found that with this *Mucor* the formation of zygosporangia depended on the sugar and nitrogen content of the culture medium. High percentages of sugar (in presence of nitrogen) induced their formation. He concludes that, the sexual process necessitating more expenditure of energy, it is the carbohydrate that furnishes the required stimulus.

A. L. S.

Study of Phycomyces.—W. SCHWARTZ ("Die Zygoten von *Phycomyces Blakesleanus*," *Flora*, 1926, 121, 1-39, 5 text-figs., 14 tables). The author has given the result of researches as to the conditions inducing the formation and germination of the zygosporangia in this species of *Phycomyces*. He observed that in a series of cultures no zygotes were formed until beer-wort was introduced. The result in the production of the first stages towards copulation-hyphæ was immediate; the further stages were delayed. Finally he discovered that zygote formation

depended on the concentration of the digested wort and on the temperature. The germination of the spore which followed depended on light and moisture.

A. L. S.

Heterothallism in *Blakeslea trispora*.—GEORGE F. WEBER and FREDERICK A. WOLF (*Mycologia*, 1927, 19, 302-7, 3 pls.). *Blakeslea* is a genus of Phycomyces hitherto known only in the sporangial stage. It appeared as a contaminant in a fungous plate culture, and advantage was taken to grow the fungus under varying conditions. The workers were fortunate in obtaining abundant zygospores. They found that the production of the zygospores was dependent on the presence of + and - strains. These strains show little difference except that one produces sporangia in greater abundance than the other. The formation of the zygospores was closely observed, and it was found that they indicated a close relationship to *Choanephora*. The mature zygospore has a large oil drop and thick exospore; it is dark brown in colour.

A. L. S.

Study of *Exoascus*.—PANCA EFTIMIU ("Contribution à l'étude cytologique des exoascées," *Le Botaniste*, 1927, 18, 1-154, 4 pls., 38 text-figs.). This paper falls into two parts:—(1) An account of the work done, and (2) general considerations and résumé. A thorough examination has been made on five species of *Exoascus* and on three species of *Taphrina*. The points of importance were the penetration of the parasite into the host-cells, the morphology of the parasite-cells, their content and nuclear divisions, fertilisation (at the end of the vegetative growth), and the action of the fungus on the host causing deformations and other changes. The writer found that generally the hyphæ of the fungus contained two nuclei; the fusion of these nuclei constituted fertilisation. She also concludes from her study that, judging from the budding of the spores, the Exoascaceæ occupy a low place in classification and show affinity with the Saccharomycetes. A long list of the literature referred to completes the paper.

A. L. S.

Studies in Discomycetes.—IV.—JESSIE S. BAYLISS ELLIOTT (*Trans. Brit. Mycol. Soc.*, 1927, 12, 290-4, 4 figs.). A careful study is given of the development of *Trichopeziza* with conidiophores and apothecial primordia. A number of related Discomycetes are also discussed.

A. L. S.

Sexuality of Ascospores.—MARGUERITE S. WILCOX ("The Sexuality and Arrangement of the spores in the ascus of *Neurospora Sitophila*," *Mycologia*, 1928, 20, 3-17, 2 pls., 2 text-figs.). By means of cultures it has been proved possible to determine the sex of the 8 spores in an ascus. The spores are numbered from the top of the ascus downwards, and it was found that when spores 1, 2, 7 or 8 were associated in cultures with spores 3, 4, 5 or 6, there was a positive sexual reaction and perithecia were found. When spores 1, 2, 7 and 8 and spores 3, 4, 5 and 6 were grown with each other, there was no perithecia, thus confirming the heterothallic character of the mycelium produced by the spores. Wilcox has made a study of the mitosis of the ascospores, the appearance and orientation of the spindle, etc. Segregation of sex-factors, she concludes, must take place in the second mitosis.

A. L. S.

Ascospore Formation.—B. O. DODGE ("Spore Formation in Asci with fewer than eight spores," *Mycologia*, 1928, 20, 18-21). Dodge has passed in review a number of instances in which the ascus contains fewer than the normal number of eight spores. In *Neurospora tetrasperma* there are normally four spores; the eight nuclei of the ascus come together in pairs, so that two nuclei, one of each sex, take part in the formation of the spores, and the mycelia developed from

such a spore are homothallic. If by chance one of the spores contains only one nucleus, no perithecia are formed. Occasionally an ascus develops only two large spores, which are each four-nucleate. Other genera in which a variable number of spores are formed in the ascus are also discussed. In some cases the reduced spore number is due to abortion or degeneration.

A. L. S.

Meliolineæ I.—F. L. STEVENS (*Ann. Mycol.* 1927, 25, 405–69, 2 pls.). The author begins with a general account of this group of fungi, tropical or subtropical forms, and widespread through South Africa, India, Australia, Central and South America. They live on the surface of living leaves and their haustoria penetrate the host-cuticle, but they do little damage as a rule, only a few species ranking as parasites. They themselves are subject to fungal parasites, and confusion in the descriptions has arisen through mistaking the fructifications of these for growth forms of *Meliola*. Stevens has given an account of his methods of preparing and examining, and also of his taxonomic views. He recognises seven genera, two of which have been established by him on the basis of perithecial appendages: *Irenina*, as previously described by him, with no setæ or larviform appendages, and *Irenopsis*, now published, with true setæ but without larviform appendages. A large number of species are new to science, a still larger number are new combinations of known species.

A. L. S.

Tropical Dothideales.—CARLOS E. CHARDON ("New or interesting Tropical American Dothideales.—I." *Mycologia*, 1927, 19, 295–301, 1 col. pl., 1 text-fig.) The present paper is based on collections by Kern and Toro in Santo Domingo and Chardon's own collections in Porto Rico. In the introduction he points out that, since very many new species have been described from these latitudes, there seems to be still a vast field for systematic mycological investigation in the territories as yet unworked. Six of the few micro-species here described are new.

A. L. S.

New Genus of the Sub-family Nitschkieæ.—R. CIFERRI (*Mycologia*, 1928, 20, 29–30, 1 text-fig.). The new genus and species *Fitzpatrickia* *Massæ* was found among material left by Dr. Caroli Massa, and is preserved in the Mycological Herbarium, Alba, Italy. The fungus grew on dead branches; the perithecia and hyphæ are furnished with black sharp prickles, the spores are simple and brown when mature.

A. L. S.

Origin of Rusts.—CLAYTON ROBERTS ORTON ("A Working Hypothesis on the Origin of Rusts, with special reference to the Phenomenon of Heterœcism," *Bot. Gaz.*, 1927, 84, 113–38). The author has made a study of the views held by different authors on the development of the life-cycle of rusts. Heterœcism was discovered in 1818, but its origin remains a mystery. Orton draws attention to the resemblance of rusts to Floridææ—the teleutospore is homologous with the tetrasporangium, the basidium with the four tetraspores. Other relationships are pointed out. Fossil rusts are few, but of those recorded only æcidium and teleutospore stages are known; it is concluded, therefore, that primitive rusts possessed both these fructifications. Orton argues that the short cycle forms arose by reduction, and he gives reasons for this view. He further discusses the great dissimilarity in the hosts of the different stages in the life-cycle. He quotes Fischer's view that originally the rusts may have been plurivorous. The alternate stages are not on related plants, the conclusion being that heterœcism is an ancient feature of the group. Finally the author decides that we should look among the red algæ, especially those that are parasitic, for evidences of development of rust-like features.

A. L. S.

Mutations in Rusts.—MARGARET NEWTON and THORVALDUS JOHNSON. ("Color Mutations in *Puccinia graminis Tritic* (Pers.) Erikss. and Henn.," *Phytopathology*, 1927, 17, 711-25, 1 pl., 4 text-figs.). The mutations occurred as colour changes in the uredinal stage of *Puccinia graminis tritici*—in one case an orange-coloured pustule appeared in the sorus, in the other the mutant was greyish-brown. Examination showed that the spore walls of the orange rust are colourless; in the greyish-brown mutant and in the normal spores they are coloured; but while the cytoplasm of the orange spore was coloured, that of the greyish-brown was colourless. Chemical investigation was also made, and there was found strong evidence that carotin was present in the normal and the orange spores; in the greyish-brown the colour was due to some unidentified compound. A. L. S.

Notes on Phragmidium.—P. DIETEL ("Über *Phragmidium Rubi* Wint. var. *candicans* Vleugel," *Ann. Mycol.*, 1927, 25, 474-7). The variety *candicans* was founded on a slight difference of spore septation in the teleutospores. Dietel has made a series of measurements of the spores, both of the species and variety, with special reference to the number of septa. The specimens were collected in eight different localities, and he found in both a similar variation in spore septation. He concludes that a distinction based on teleutospores alone is not specifically sufficient. A. L. S.

Experiments on Smut Infection.—SYDNEY DICKINSON ("Experiments on the Physiology and Genetics of the Smut Fungi.—Seedling Infection," *Proc. Roy. Soc., Series B*, 1927, 102, 174-6). Dickinson refers back to a previous paper in which he showed that of the four cultures grown from the sporidia of a single chlamydospore, two were of one sex, two of another, and that fusion of hyphæ occurred only between the opposing sexes. The same results occurred while infecting seedlings with cultures. No infection took place with one sex; when hyphæ of both sexes were present, 90 p.c. infection and over was obtained. A. L. S.

Resistance to Rust Disease.—S. J. WELLENSIEK ("The Nature of Resistance in *Zea Mays* L. to *Puccinia Sorghi* Schw.," *Phytopathology*, 1927, 17, 815-25, 2 pls.). Tests were made by inoculation with two physiologic forms of *Puccinia Sorghi*, and it was found that certain lines were resistant to one form and some to the other. The whole question of resistance was studied. It was proved by histological study, in the course of infection, that there were differences in the resistant and susceptible host-plants as to the rate of development of the rust, the number of spores formed, etc. Evidence was afforded that to some extent immunity might be nothing but extreme resistance. There was no proof of the action of toxins or antitoxins. A. L. S.

Discussion on Uredineæ.—Z. H. MOSS ("The Uredinia of *Cronartium Comandrae* and *Melampsora medusæ*," *Mycologia*, 1928, 20, 36-40.) Moss has compared representatives of the Pucciniastrea, Cronartieæ and Melampsoreæ, and finds that they are essentially alike in the mode of development of their uredinia. They differ markedly in size and shape of the pustules and in characters of spore and peridium, but these he regards as of secondary importance from a phylogenetic point of view. His conclusions have considerable bearing on affinities, but still more work is required before definite views can be stated. A. L. S.

Notes on Arctic Uredinales.—J. C. ARTHUR (*Mycologia*, 1928, 20, 41-3). The writer discusses the presence of long and short cycle forms in polar areas, the

latter being the more frequent. Many rusts, he considers, contrive to exist without the alternate host. As to distribution, it is considered that the wind is the main agent.

A. L. S.

A New Fern Rust.—H. W. THURSTON ("An Interesting Fern Rust new to the United States," *tom. cit.* 44-5). The rust was found on *Polypodium vulgare* and had been named *Uredinopsis polypodophila*. The alternate host, *Abies balsamea*, grew nowhere in the vicinity, but it is suggested that late urediniospores may overwinter and germinate in spring.

A. L. S.

Control of Smut.—L. E. MELCHERS ("Studies on the Control of Millet Smut," *Phytopathology*, 1927, 17, 739-41.) The control tests were applied in Kansas, where millet (*Setaria italica*) is grown in a large number of counties. The most important disease affecting the crop is due to the smut *Ustilago Crameri*. The treatments applied were solutions of formaldehyde, copper sulphate and Uspulun. The dry treatment consisted of copper carbonate dust applied to the seed. It was found that the dust gave by far the best results, and that formaldehyde should never be used on the seed; it seriously injures the germination.

A. L. S.

Heterothallism in Ustilago Zeæ.—E. C. STAKMAN and J. J. CHRISTENSEN (*Phytopathology*, 1927, 17, 827-34). Experiments were made by inoculating varieties of corn with physiologic forms of *Ustilago Zeæ*. The conclusion reached was that the smut is heterothallic, the fusion of two strains of opposite sex being necessary for the formation of chlamydospores. Similar results were obtained in the effect on the host: galls were formed only when the host-plant was inoculated with two forms presumably of opposite sex. It was observed also that hyphal fusions and clamp connections took place in the host-plant inoculated with two strains of opposite sex.

A. L. S.

Spores of Sterigmatocystis nigra.—ALB. FREY ("La formation des cellules géantes du *Sterigmatocystis nigra*," *Rev. Gén. Bot.*, 1927, 39, 277-305, 7 text-figs.). Large cells have been observed to be formed in cultures of *Sterigmatocystis nigra*, a fungus akin to *Aspergillus*. Frey has made a study by cultures to explain their physiology. He found that, in the cultures, they increased by division recalling the budding of yeast cells. Various media were employed, both acid and alkaline, and as a result he found that these large cells were formed when there was a lack of potassium or an excess of acidity in the culture medium.

A. L. S.

Development of Boletinus.—R. KÜHNER ("Le Développement du *Boletinus cavipes* (Opat) Kalch," *Le Botaniste*, 1927, 18, 177-81, 1 pl.). Kühner has studied the development of the sporophore from the early stages. He finds that the hymenium has an external origin, but becomes closed in by marginal proliferations of the pileus; it is a kind of *pseudoangiocarp*. The development of the hymenial cells is centrifugal on the pileus. The stalk is hollow except towards the summit.

A. L. S.

American Agaricaceæ.—LOUIS C. C. KRIEGER ("New or otherwise interesting Agaricaceæ from the United States and Canada," *Mycologia*, 1927, 19, 308-14, 6 pls.). The plants described are new, or new varieties of Agarics previously known. A new *Mycena*—*M. inconspicua*—"grew caespitously on naked soil at a street corner" of Baltimore.

A. L. S.

Determination of Fungi by Mating.—A. H. REGINALD BULLER and DOROTHY E. NEWTON ("The mating method of Identification of a *Coprinus* growing on germinating seeds of Mangel and Sugar-beet," *Ann. Bot.*, 1927, 41, 663-70, 1 pl., 6 tables). The mating of fungus hyphæ from different sources so that clamp connections were formed in cultures has been successfully employed by the writers to identify a *Coprinus* that appeared on germinating seeds of mangel, beet and sainfoin in England and on germinating sugar-beet in America. It resembled morphologically *Coprinus lagopus*, which grows on horse-dung in pastures both in Europe and North America. The mating of the hyphæ between these different specimens and the formation of clamp connections proved undoubtedly the identity with *C. lagopus*.
A. L. S.

Cytological Study of *Mycena galericulata*.—R. KÜHNER ("Étude cytologique de l'hyménium de *Mycena galericulata* Scop.," *Le Botaniste*, 1927, 18, 169-76, 1 pl.). Kühner has first of all established in *Mycena galericulata* that some forms have four-spored basidia, others two-spored. He has concentrated attention on the latter. The sub-hymenial hyphæ are uninucleate, and the division of the nucleus into two daughter nuclei is described and figured in great detail. After development of the sterigmata the nuclei pass into them, but become "broken" in the passage—possibly a mitosis—and the spores are in consequence bi-nucleate. The results are compared with those published by René Maire and by Wager on the four-spored forms.
A. L. S.

Fruiting of *Collybia dryophila* in Pure Culture.—R. F. POOLE (*Mycologia*, 1928, 20, 31-5, 2 pls.). The fungus was readily developed by planting on prune agar the mycelium and rhizomorphs from dewberry roots on which it is parasitic. Poole has given a full account of the development, rates of growth, and size of the plants. Greatest uniformity was shown when the plants grew singly.
A. L. S.

Phalloideæ.—E. FISCHER ("Phalloideen aus Surinam," *Ann. Mycol.*, 1927, 25, 470-3). The author comments on the difficulty of studying the Phalloids on account of their transitory nature. The present study has been made possible by the collector preserving the plants in alcohol. Fischer found them of extreme interest. He describes eight species, three of which are new: *Clathrella Staheli*, *Ithyphallus paucinervis*, and *Mutinus (Jansia) granulatus*. He also notes the occurrence of the small species *Mutinus xylogenus* Mont. in Surinam. It was originally found in S. America (Cayenne, French Guiana). The present paper is preliminary to a more detailed account of the collection.
A. L. S.

Septobasidium rameale.—T. PETCH (*Trans. Brit. Mycol. Soc.*, 1927, 12, 276-82, 2 pls.). In this paper Petch clears up the ambiguity attached to *Lachnocladium rameale*, *Septobasidium rameale*, and *Thelephora suffulta*. He recognises two, both of them species of *Septobasidium*. One of these he lists as *Septobasidium pteraloides* Pat., and the other *S. aligerum* Petch. Full descriptions are given of both these fungi.
A. L. S.

Studies in Fungal Parasitism.—W. BROWN and C. C. HARVEY ("Studies in the Physiology of Parasitism. X.—On the Entrance of Parasitic Fungi into the Host-Plant," *Ann. Bot.*, 1927, 41, 643-62, 1 text-fig.). Experiments were made with the spores of *Botrytis cinerea* on various permeable substances—membranes of gelatine and membranes of plant leaves. The methods and results are fully described. The conclusion by the writers was that penetration by the fungal hyphæ took place easily with gelatine membranes, that *Allium* leaf-scales and

membranes of *Eucharis* leaves were readily penetrated from either side, but the epidermis of *Eucharis* could not be entered unless the cells were turgid. Finally they point out that the stimulus to penetration is one of contact, and that the method of penetration is purely mechanical.

A. L. S.

Notes upon Reviving Old Cultures.—ALFRED POVAH (*Mycologia*, 1927, 19, 317–19). The writer has discovered that fungus cultures which have seemingly lost all vitality may be revived by the use of hot agar. A specimen of *Sclerotium Rolfsii* was thus induced to begin new growth. The culture was over five years old. A table is given of the various fungi and their age that responded to the treatment. The oldest of the list was *Sclerotium Rolfsii*, five years five months fourteen days.

A. L. S.

Three Mycological Contributions.—ROMUALDO GONZÁLEZ FRAGOSO ("Tres notas micológicas," *Bol. Real Soc. Esp. Hist. Nat.*, 1927, 27, 346–58). Fragoso deals here with Spanish fungi from three localities: from the Spanish Pyrenees, collected by Pannero, other Pyrenean species in the herbarium at Barcelona, and a third series from the Province Orense. In these papers he deals entirely with microfungi. The Uredineæ are specially well represented in all the lists.

A. L. S.

Mycological Survey of Porto Rico and the Virgin Islands.—H. M. FITZPATRICK (*Mycologia*, 1927, 19, 144–9). The author gives an account of the work done on these islands since they were taken over from Spain. It is expected that the finished paper will be of great service to students in the tropics. The list appended gives only new genera, new species, and new combinations. Some families and genera are as yet poorly represented, and require more close attention. Of Myxomycetes 41 species have been included in the list. In the large group of Phycomycetes only 20 species have been recorded.

A. L. S.

Mycological Flora of Czechoslovakia.—RICHARD PICBAUER ("Addenda ad floram Czechoslovakie mycologicam III," *Bull. École Sup. d'Agron. Brno. R.Č.S., Faculté de Silviculture*, 1927, 3–25). Picbauer begins with a considerable number of Myxomycetes; thereafter he lists fungi from all the main groups. He describes two new species of parasitic Pyrenomycetes and a new species of Fungi Imperfecti. Hosts are recorded in the case of parasitic species, habitat and locality for all.

A. L. S.

Mycophagic Notes.—W. A. MURRILL (*Mycologia*, 1927, 19, 151–2). Murrill recommends the yellow-gilled *Russula* as a good table fungus. He does not give the specific name nor any recognisable description. Notes on cooking are added, and other species are also recommended. These fungi grew in Florida.

A. L. S.

Effect of Vitamines on Fungus Cultures.—G. MENKÈS ("Recherches sur l'action des vitamines sur les champignons," *Compt. Rend. Soc. Phys. Hist. Nat. Genève*, 1927, 44, 91–4). Two species, *Aspergillus niger* and *A. fumigatus*, were subjected to culture tests. A solution of vitamines was introduced into a spore culture and the dry weight was measured after certain periods. The results were the same, a heightening in both cases. There were also unexplained characters—differences of colour, odour and acidity. Sugar was more strongly assimilated, but whether that was due to greater permeability of the mycelium or to acceleration of growth has not been fully determined.

A. L. S.

Capnodium as a Disease of Cotton.—A. SAWNEY ("Studies in the Biological and Cultural Characters of *Capnodium* sp. on Cotton," *Journ. Ind. Bot.*

Survey, 1927, 5, 141-86, 3 tables, 8 pls.). The fungus *Capnodium* was found by the writer on American and local Indian cotton grown from seed at Lahore. It appeared as black spots on the midrib of the under surface. It was found also that, in the case of cotton, the fungus did not live on honey-dew, but on the secretions of the glands—nectar glands of the midrib and principal veins on the underside of the leaves. Great damage is done to the host both by lowering its vitality and by thus rendering it an easy prey to other diseases. The lowering effects are seen in the bolls, which are liable to insect pests and produce no good fibres. The chief reproductive agents of the fungus were pycnidia. Torula-like spores were abundant, but no perithecia were seen. In coverslip cultures oogonium and antheridium-like structures were produced. Many physiological tests were made by varying the different media with asparagin and maltose, and by testing the effect of light and of moisture both on the development of pycnidia and on the rate of growth. A. L. S.

Parasitology of *Sclerotium Rolfsii*.—RUTH DAVIS PAINTIN ("Notes on the Parasitology of *Sclerotium Rolfsii*," *Mycologia*, 1928, 20, 22-6, 2 pls., 1 text-fig.). *Sclerotium Rolfsii* is a very widespread parasite of many different plants, and causes considerable loss. It was considered to be a weak parasite with no special host preference. It is not necessarily a wound parasite; the spores may pierce the cell-wall and seem to gain entrance by mass action. The hyphæ are both inter-cellular and intracellular, and they pass from cell to cell without constriction. "In the final phases all that remains of the host are a few disorganised fragments of the cell-walls among the extensive mat of the hyphæ." A. L. S.

Parasitic Fungi.—L. R. TERON and E. V. DANIELS ("Notes on the Parasitic Fungi of Illinois—III," *Mycologia*, 1927, 19, 110-29, 1 pl.). The list of fungi forms part of the regional survey of Illinois. It contains an account of 5 Ascomycetes and 29 Fungi Imperfecti, the latter mainly Sphærospideæ. The species are mostly new or new combinations. Two new genera of Ascomycetes are described: *Rostrophæria* (Gnomoniaceæ) and *Ezilispora* (Sphæriaceæ). A. L. S.

Oregon Fungi.—S. M. ZELLER ("Contributions to our Knowledge of Oregon Fungi—II. Mycological Notes for 1925," *Mycologia*, 1927, 19, 130-43, 4 text-figs.). Most of the fungi recorded grew on leaves, wood, etc. Three new species of Ascomycetes have been described, and descriptive notes are given of rare or doubtful species. A. L. S.

Thread Blight Disease.—FREDERICK A. WOLF and WALTER J. BACH ("The Thread Blight Disease caused by *Corticium Koleroga* (Cooke) Höhn., on *Citrus* and on Pomaceous Plants," *Phytopathology*, 1927, 17, 689-709, 10 text-figs., 1 pl.). The disease called thread blight occurs on a large and varied series of plants and attacks leaves, twigs, and fruits. It is characterised on apples by the presence of brown rhizomorphs and sclerotia on twigs and fruits. Affected leaves hang down, being attached by the rhizomorph threads. The fungus gains entrance to the host plant through the stomata and spreads between the cells. The effect of the parasite on the host tissues is described. It was first detected on coffee sent from Mysore, India, and was variously diagnosed. Von Höhnelt finally assigned to it the name *Corticium Koleroga*. It has been known in the United States since 1907. It hibernates by means of sclerotia. The authors recommend spraying with Bordeaux mixture as a means of checking the disease. The attack on grape-fruit in Florida was controlled by a single application. A. L. S.

Disease Control of Potatoes.—J. M. RAEDER and C. W. HUNGERFORD ("Seed Treatment Control of Rhizoctonia of Potatoes in Idaho," *Phytopathology*, 1927, 17, 793–814). The most effective method of control was to moisten the potatoes first. The pre-sprinkling was carried out 48 hours before treatment, the potatoes being kept moist during that time. Tests were made thereafter with a series of disinfectants, the best control being obtained by sprinkling with Semesan dust before cutting. A long series of tables is given, thus providing data as to the result of each experiment.
A. L. S.

Elm Disease.—MALCOLM WILSON and M. J. F. WILSON ("The Occurrence of the Dutch Elm Disease in England," *Gard. Chron.*, 1928, 83, 31–2, 4 text figs.). The name, Dutch Elm Disease, refers to the country of origin. It appeared in Holland in 1919, and since that date has spread over the whole country, Belgium and Western Germany. Now it has appeared in North London. The first symptoms are the dying and falling leaves, soon followed by the death of the tree. Examination shows brown spots and streaks beneath the bark of tree and root. Cultures of the diseased tissues almost invariably give a growth of a Hyphomycete, *Graphium Ulmi* Schwarz. But in the cultures there are also growths of cocci and bacterial rods. Opinion is still divided as to the cause of the disease. It is extremely desirable that any outbreak of the disease should be reported at once to the Ministry of Agriculture.
A. L. S.

Lichens.

Recent Lichen Literature.—A. LORRAIN SMITH (*Trans. Brit. Mycol. Soc.*, 1927, 12, 231–75). The present paper takes cognisance of contributions on the subject of lichens that have appeared since 1925, the date of the last similar communication. Nearly all aspects of lichen development have been considered by the various authors, but most attention has been given to distribution and ecology, subjects which are at present claiming a great deal of attention. Since lichens are so frequently pioneers, their importance in any general ecological study is coming more into prominence, hence the many publications devoted to the habitats of the lichen plant and their relation to each other as well as to other members of plant associations. There is a long list of papers cited, which includes the literature of the past few years.
A. L. S.

Lichens on the Lydites near Klatovy.—ALFRED HILITZER ("Přspěvky K. Sisejníkům Sumavy a Pošumaví," *Zvl. Otisk z Časopisu Národního Musea*, 1927, 1–15). With French *résumé*. Hilritzer describes two groups of lydite rocks; the widest surfaces are exposed to the south-east generally vertical. The tops of the rocks are almost naked, others have only a lichen vegetation. He describes 15 different associations marked each by some dominant lichen. Some of these are calcicole from remains of lime of a broken-down building, others are nitrophilous due to the excreta of birds on the rocks. The species most characteristic of lydite rocks are: *Pertusaria lactea*, *P. corallina*, *Gyrophora polyphylla*, and *Parmelia Mougeotii*. In general the lydites have a vegetation very different from that of schists.
A. L. S.

Lichenology of Serpentine Soils.—JINDRICH SUZA ("Lichenologický Ráz Západočeských Serpentinů," *Zvl. Otisk z Časopisu Morav. Zem. Musea*, 1927, 25, 1–32). In this paper SUZA gives an account of the lichenological character of the serpentine soil of West Bohemia. The chief association there is the *Ericeta*, *Calluno-ericeta*, and lichens in the district are described as (1) terrestrial associa-

tions mingled with the heaths, and (2) epilithic associations. In the first, *Cladonia* are the most abundant. On the serpentine rocks—silicates with little lime—there is an astonishing absence or scarcity of certain epilithic species such as *Rhizocarpon geographicum*, *Lecanora glaucoma*, *Diploschistes scruposa*, etc., as well as of all species of Gyrophoraceæ which grow freely on the surrounding schists. Another feature of serpentine is its great dryness, which partly explains the lack of lichens and mosses. In places frequented by birds nitrophilous species were abundant. Obligate lime lichens were not found on the serpentine. Comparison is made with the vegetation on the serpentine of other localities.

A. L. S.

Japanese Lichens.—A. ZAHLBRUCKNER ("Additamenta ad Lichenographiam Japoniæ," *Bot. Mag., Tokio*, 1927, 41, 313–64, 2 pls.). There are listed 208 species belonging to a varied series of families and genera. Many of the species are new to science, a considerable number are world-wide species.

A. L. S.

Lichens of the Isle of Man.—J. W. HARTLEY and J. A. WHELDON (Supplement, *North Western Naturalist*, 1927, 2, 13–38). The systematic portion of the Supplement has been continued and finished. It includes many interesting species, as, for instance, *Cetraria aculeata* f. *peregrina* (form. nov.) in globular unattached masses—a new erratic lichen. Localities and habitats are carefully recorded, and numerous biological notes are supplied by the authors.

A. L. S.

Lichenological Notes.—BOULY DE LESDAIN ("Notes lichenologiques—XXIII," *Bull. Soc. Bot. France*, 1927, 74, 436–9). A series of notes on lichens from France and Italy, and the publication of new species, varieties and forms. Full descriptions are given of the new plants, and useful comparisons are indicated with others. He finds that a plant considered by him to be *Lecidea acutula* Arn. and one of Martindale's specimens so named are identical with *Toninia caradocensis*. He also describes a new *Verrucaria* from Mexico.

A. L. S.

Note on Pseudoleptogium.—MAURICE CHOISY ("Qu'est-ce que Pseudoleptogium Müll-Arg.?" *Arch. Bot.*, 1927, 1, 139–40). Under the name *Pseudoleptogium diffractum* a number of different species have been included. Of these Choisy finds that *Leptogium diffractum* Krempelsh is doubtful; *Collema leptogioides*, quoted as a synonym, is entirely different; *Leptogium placodellum* has a cellular thallus and may possibly be a *Pterygium* or *Placynthium*.

A. L. S.

Lichen Morphology and Biology.—K. GOEBEL ("Morphologische und biologische Bemerkungen. 32. Induzierte Dorsiventralität bei Flechten," *Flora*, 1926, 121, 177–88, 3 figs.). Experiments and observations were made by Goebel on the thallus of *Peltigera aphthosa*. The thallus is normally dorsiventral, but the apothecia, which lie flat at the apex of the lobes, occasionally turn the under side to the light. This happens when algæ alight on these portions, are seized on by meristematic hyphæ, and a tissue similar to the upper surface tissue is formed; the meristematic hyphæ in that case produce lichen acids. He has also observed radiate podetia of *Cladonia* become dorsiventral; thus *Cladonia furcata* in certain circumstances of light exposure becomes grey and squamulose on the illuminated side, the shady side being esquamulose and almost white. Dorsiventrality is due to the algal layer of the upper surface and the necessity for illumination. The "air" hyphæ are developed on the under side and produce lichen acids which protect them from water absorption.

A. L. S.

Lichens of Jeseniky.—ALFRED HILITZER ("Notes sur quelques Lichens récoltés dans les Jeseniky," *Preslia*, 1927, 5, 1-3). There is given a floristic account of the lichens of mountains on the eastern side of the Sudètes, and a comparison is made with the lichen vegetation of Krkonoše. Among other species Hilitzer notes *Thelopsis melathelia*, an Alpine lichen. A northern species, *Parmelia infumata*, also occurred on the mountains. Hilitzer considers that it is a relic of glacial times. It was found in somewhat nitrophilous surroundings. A. L. S.

Lichens from Peru.—G. K. MERRILL ("A List of the Peruvian Lichens by G. Buës," *Bryologist*, 1927, 30, 83-8). The collection was made during the years 1919 and 1920, and was presented to Yale University. G. K. Merrill (now unfortunately dead) named the specimens. Localities and altitudes are given. The lichens are mostly of the larger species; there is almost a total absence of crustaceous forms. A. L. S.

Russian Lichens.—A. H. MAGNUSSON ("New Species of Lichens in the North of U.S.S.R.," *Bull. Jard. Bot. Princ. U.S.S.R., Leningrad*, 1927, 26, 1-12). Magnusson has determined lichens from 10 northern stations in Lappland, Finland, Nova Zembla, Isle of Kolguev and the Arctic Ural. He has listed 104 species, forms, or varieties, some of them new to these regions, and four species new to science. A. L. S.

New Descriptions of Lichens.—A. H. MAGNUSSON ("Descriptions of new or not properly defined Lichens," *Medd. Från Göteborg's Bot., Tradgård*, 1927, 3, 11-23). Magnusson has included here descriptions of the new species published in his account of lichens in North Russia (see above). Along with these are new or newly described species, mostly from N. or S. America. A. L. S.

Study of Epiphyllous Lichens.—F. SCHILLING ("Entwicklungsgeschichtliche und systematische Untersuchung epiphylla Flechten," *Hedwigia*, 1927, 67, 269-300, 2 pls.). Schilling has given the results of his examination of genera and species, usually included in the family Strigulaceæ. They are tropical lichens, living on the leaf surface of rather thick-leaved trees. The gonidial symbiont is *Phycopeltis* or *Trentepohlia* (Sect. *Heterothallus*). From Strigulaceæ Schilling has separated two genera which he makes the representatives of two new families, *Phyllobatheliaceæ* and *Trichotheliaceæ*. In the latter family he includes not only *Trichothelium*, but *Stereochlamys*, a genus of Pyrenulaceæ. He has sunk the genus *Haplopyrenula*, as the distinguishing simple spore-character is incorrect. Species of *Phylloporina* have been transferred to *Porina*. Schilling deprecates the insistence on the type of alga as a wholly important character. Even in the higher lichens several kinds of algæ form the gonidia of a genus. A. L. S.

Physiology of Lichens.—OTTO STOCKER ("Physiologische und Ökologische Untersuchungen an Laub- und Strauchflechten," *Flora*, 1927, 121, 334-415). Stocker describes his paper as a contribution to the experimental ecology and geography of Lichens. He has presented a study of the physiology of growth and distribution, in which he stresses the necessity for physiological observations in the study of lichen ecology. He deals with the various factors in lichen growth in turn. In the case of the water factor, rain, dew, or mist is essential to assimilation, moist air alone is insufficient. As to light, there are shade lichens which must take advantage of any ray of sunlight. Lichens with full exposure do not require excess of sunlight for assimilation, and they can flourish in lower temperatures than shade lichens. *Umbilicaria pustulata*, that grows in the open, is contrasted with *Lobaria pulmonaria*, a tree lichen often in the shade. It is hurtful to

lichens to be subjected to strong light when they are fully saturated; there is a too rapid evaporation inducing a dry condition not favourable to assimilation. There are two maximum temperatures for assimilation—10°–15° C. and 25°–30° C. The first of these temperatures is generally present in lichen districts with a more or less frequent rainfall. A. L. S.

Cultures of Lichen Hyphæ.—R.-G. WERNER ("Influence du milieu sur la croissance des Champignons de Lichens," *Comptes Rendus Acad. Sci.*, 1927, 185, 1149–51). Werner's aim in making his cultures was to ascertain the equilibrium between the alga and the fungus of lichens by testing the hyphæ on different culture media. Many of the media were composed of malt glucose or agar containing glucose and traces of salts, etc. Pepton and asparagin were selected as sources of organic substances, and nitrate of ammonium for inorganic nitrogen. These were used in different proportions in the various cultures. At the end of six months measurements were made. Growth was active in 1 p.c. glucose, and at its minimum on agar containing urea. *Sticta* hyphæ alone grew relatively well on urea. In general, glucose was preferred to galactose. Where the two symbionts were united, the alga exercised a certain influence on growth—the fungus grew less rapidly—while in most of the cultures the alga flourished best, except on certain media which he proposes to experiment with in future tests. A. L. S.

Study of Moriolaceæ.—KARL KEISSLER ("Ueber die als Pilze anzusehenden Arten unter den Norman'schen Moriolaceen," *Nyt. Mag. Naturv. B.*, 1927, 66, B., 77–92). Keissler has taken up Bachmann's work on Moriolaceæ, a family of lichens with peculiar development, originally described by Norman. Keissler has studied the genera and species, and in nearly all cases he is convinced that the organism is a fungus. He has identified these various species with genera and even with species of fungi already described. Just a few species he considers to be doubtful. A. L. S.

Fungi Parasitic on Lichens.—KARL KEISSLER ("Systematische Untersuchungen über Flechtenparasiten und lichenoiden Pilze," *Ann. Naturhist. Mus., Wien*, 1927, 41, 157–70, 2 text-figs.). Special attention is given in this paper to *Cyphella cruginascens* Karst. Keissler finds that it is synonymous with the genus *Chlorocyphella*, and he has traced its history through mycological and lichenological literature. He has also described several varieties of this widespread lichen parasite. Notes are given on several rare parasitic fungi described as lichens, and on *Hymenobolina parastica*. A. L. S.

Mycetozoa.

American Slime-Mold.—ROBERT HAGELSTEIN ("An interesting Discovery of a rare Slime-mold," *Mycologia*, 1927, 19, 315–16). The mycetozoon in question, *Enerthenema Berkeleyanum*, is a very rare species; it differs from the only other species of the genus in having clustered spores. First recorded from S. Carolina, it was collected again many years later by Sturgis in Colorado. The present specimen was collected in Nassau County, New York. It appeared on a spruce lath which had come from Nova Scotia two days before it was observed. Critical notes are given as to growth and to the systematic position of the genus. A. L. S.

Mycetozoa in the Soil.—HELENA I. SEWERYN KRZEMIENIEWSKY ("Z Mikroflory gleby w Polsce. Contribution à la microflore du sol en Pologne," *Acta Soc. Bot. Poloniae*, 1927, 4, 141–4. Polish with French résumé). In a study of soil myxobacteria the authors found a number of myxomycetes. In this paper they

have only dealt with the Acrasieæ, three species of which were more or less abundant. *Dictyostelium mucoroides* occurred in nearly all the soils examined, either cultivated or uncultivated. Two species of *Polysphondylium* were less abundant and were rarely found in cultivated soils. Their favourite habitat was peaty formations, damp and full of humus. The results were worked out at the Inst. Biol.-Bot. Univ. Leopold.

A. L. S.

Myxomycetes from British Guiana and Surinam.—FRANK A. GILBERT (*Mycologia*, 1928, 20, 27-8). The mycetozoa recorded formed part of a collection of fungi made by Dr. David Linder. The species listed are stated by Gilbert to be neither new nor even extremely rare, but their interest lies in the new localities, which considerably extend the range of species. Tropical specimens are, as a rule, poorly represented and any additions are valuable.

A. L. S.

TECHNICAL MICROSCOPY.

Polishing and Etching Lead, Tin, and Some of Their Alloys for Microscopical Examination.—J. R. VILELLA and D. BERECEKOFF (*Ind. Eng. Chem.*, 1927, 19, 1049-52). Stress is laid upon the careful polishing of lead and lead-base alloys, so as to avoid disruption of the surface. The sample is cut with an oiled hack-saw and ground on coarse emery smeared with a kerosene solution of paraffin until at least $\frac{1}{32}$ inch has been ground away. The speed of the revolving disc should not exceed 500 r.p.m. Further grinding is done successively on No. 2, No. 1, No. 0, No. 00 and No. 000 emery papers similarly greased with a paraffin solution. An additional grinding on old No. 000 paper is also desirable. Wet polishing is now done on clean broad cloth smeared with soap, using an aqueous suspension of finest alumina as the abrasive. This is followed by a similar treatment on silk velvet, when, after well washing, the sample is etched. In the case of lead and lead-antimony alloys, a reagent of 1 part HNO_3 , 1 part CH_3COOH , and 4 parts glycerol is used. For lead-tin alloys twice as much glycerol in the reagent is used, and for pure tin a reagent consisting of 1 vol. HNO_3 , 3 vols. CH_3COOH , and 5 vols. glycerol is employed. The specimens are first warmed in a current of hot water and then immersed in the reagent for a few seconds only. Polishing on silk velvet and re-etching are continued as long as improvement is noted in the appearance of the surface.

A. H.

Method for Cutting and Differential Staining of Microscopic Sections of Hardwood Glue Joints.—A. I. WEINSTEIN ("Fourth Colloid Symposium Monograph, 1926, 270-80, *Chem. Abstr.*, 1927, 21, 3485). Various methods of soaking and preparation are described. The stain used was prepared from Malachite green 0.5 gm., acid fuchsin 0.1 gm., Martius yellow 0.01 gm., distilled water 150 cc. and 95 p.c. alcohol 50 cc.

A. H.

Microscopical Examination of "B" Powders.—J. DESMAROUX (*Mém. Poudres*, 1927, 22, 259-84, through *Brit. Chem. Abstr. B*, 1928, 47, 70).

scopical examination shows that the cotton fibre structure is not altered by nitration, but by the pulping. Differential staining methods are described for the detection of poorly dehydrated and unwashed powders. A. H.

Light-Scattering Capacity (Tyndal Effect) and Colloidal Behaviour of Gelatin Sols and Gels.—E. O. KRAEMER and S. T. DEXTER (*Journ. Phys. Chem.*, 1927, 31, 764–82). The variation of light-scattering properties of gelatin solutions with pH has been studied. Scattering was found to have a maximum value at the isoelectric point, the actual pH of which depends upon the grade of gelatin used. The effect of addition of acid and alkali, as well as the influence of temperature on the Tyndal effect, have been investigated, and a detailed discussion on the disperse nature of gelatin solutions is given in the light of the results obtained. W. J. E.

Transparency of Fused Silica to Ultra-Violet Radiations.—M. TSUKAMOTO (*Compt. rend. de la Soc. de Biol.*, 1927, 185, 55–57). The coefficient of absorption of purest grade of fused silica for ultra-violet radiations measured over the range 1862–2182 Å°. The transparency diminishes rapidly for wave-lengths below 2100, but in the neighbourhood of 1930 the curve becomes less steep, and extrapolation would indicate that the fused silica examined still possesses appreciable transparency at $\lambda = 1500 \text{ Å}^\circ$. W. J. E.

Investigation of Colloidal Systems.—N. N. ANDREEV (*Koll Zeit.*, 1927, 43, 14–17). Investigation of various disperse systems described by a method based upon the measuring of the amount of scattering occurring when light traverses the solution. The scattering is measured by the aid of a potassium photo-electric element. Colloidal colophony, barium carbonate suspensions, staphylococcus albus suspensions, sulphur solutions, and mastic solutions, have been investigated by this method. W. J. E.

Studies in Ultrafiltration.—HANS ZINNER and FEI-FANG TANG (*Journ. Exp. Med.*, 1927, 46, 357–378). Experiments endeavouring to arrive at the magnitude of some of the so-called filterable viruses by comparing their filterability through ultrafilter membranes with the filterability of various known colloids. Order of magnitudes arrived at: cryst. egg albumin; cryst. serum albumin; trypsin; collargol; casein; bacterophage; Rous sarcoma virus; herpes virus; arsenic Trisulphide. W. J. E.

NOTICES OF NEW BOOKS.

Biological Monographs and Manuals.—The Species Problem. By G. C. ROBSON, M.A. 1928. vii, 283 pp. Published by Oliver & Boyd, Tweeddale Court, Edinburgh. Price 15s.

Collected Physical Papers of Sir Jagadis Chander Bose, M.A., D.Sc., F.R.S., etc.—Longmans, Green & Co., Ltd. (From the Bose Institute Transactions.) Price 10s.

A collection of some twenty-eight papers, mainly physical, dating from the year 1895, is published in the present volume. It is evident, therefore, that they are not only on recent work, but, as stated by Sir J. J. Thomson in a foreword, they mark the dawn in India of a revival of interest in physical science. Some are strictly physical, particularly the earlier ones, while others are an account of the application of physical methods to biological problems that Sir J. C. Bose has made particularly his own. It is not possible to draw attention to any single paper that is of special importance to microscopists. At the same time many will find much of interest if a broad view is taken of the modern trend of microscopy. After all, microscopy is in its essentials the use of strictly physical methods in problems that may be either physical or biological or both. As a source of inspiration and as providing an unusual outlook on such problems, this book may be recommended. It is always pleasant reading, and this cannot be said of many such books.

J. E. B.

Structure and Development of the "Living Matter."—By F. VEJDOVSKY. 1926-7. vii, 360 pp., 24 plates, 3 text-figs. Published by The Royal Bohemian Society of Sciences, Prague.

This volume has been published with the assistance of the Ministry of Education of the Czechoslovak Republic, which has rendered possible the production of twenty-four magnificent plates, nine of which are in colour.

The writer claims to have been the first to demonstrate, in 1887, that the well-known theories of the reticular, fibrillar, granular, homogeneous and alveolar structure of protoplasm did not apply to all kinds of living matter. In examining the egg of *Rhynchelmis* he showed that there was no exclusive structure, but that alternating structures occur, an explanation which was ignored until Kölliker, and later Fleming, in 1897, arrived at the same conclusion.

The advances in colloid chemistry have shown that protoplasm is a polyphase colloidal system in which all the visible structures have to be explained as spatially differentiated parts of the protoplasm which by localisation and specialisation of certain functions have achieved permanent individuality.

To determine the value of this view the writer has examined the most diverse forms of life in an attempt to ascertain homologous organisations and their eventual differentiation in the resting stage and their transformation in the course of development.

Beginning with the spermatogenesis of the crayfish, it is shown that the mitotic apparatus appears in the form of a great number of minute granules, each of which is connected with a spindle fibre. It is then shown that the organisation of the spindles in the eggs and the origin of the maturation spindles and blastomeres

of *Ascaris* conform to the same type, and that similar organisations can be demonstrated in the higher plants (Angiosperms) and in the mammals such as the rock kangaroo and the guinea-pig. In a final chapter the organisation and genetic continuity of the cell constituents are discussed. This volume forms an important contribution to the comparative cytology of the mitotic apparatus. G. M. F.

Spectroscopy.—By E. C. C. BALY, C.B.E., M.Sc., F.R.S. Volumes I, II and III. Third edition. 1924-1927. Published by Longmans, Green & Co., 39, Paternoster Row, E.C. 4.

It has become necessary to publish this work, the standard one on its subject in English, in four volumes, three of which are now available. The subject of spectroscopy is now so vast that anything like an exhaustive treatise is bound to be of considerable dimensions. In the first volume an account is given of the standard methods of work in the infra-red, visible and ultra-violet regions of the spectrum, and it therefore covers most of the ground that is of interest to microscopists. The second volume also deals in large part with instrumental methods, such as the use of the interferometer, methods of illustration and photography of the spectrum. The third volume deals with those aspects of the subject which are associated with recent developments in atomic theory, in which the origin of spectra plays so large a part. This work, so far as it is yet published, provides English readers with a delightfully readable account of the subject it presents, while the name of the author is sufficient guarantee of its scientific accuracy.

J. E. B.

Hunting Under the Microscope.—By Sir ARTHUR E. SHIPLEY, G.B.E., F.R.S. 1928. 184 pp., 34 figs. Published by Ernest Benn, Ltd., Bouverie House, 154, Fleet Street, London, E.C. 4. Price 8s. 6d.

This last, and posthumously published, book by the late joint editor of the Cambridge Natural History has been ably edited by Mr. Cecil Pantin, of the Plymouth Marine Laboratory. It was written for the elementary student and for the many people of all ages who are fascinated by the wonder and mystery of the microscopic forms of life to be found in the freshwater ponds of the countryside.

The first two chapters give an interesting account of examples of suspended animation and hibernation in the animal kingdom. Then follow in zoological sequence, from the amoeba to the mosquito, chapters in which are aptly portrayed the characteristics and peculiarities of the more familiar freshwater species. The author's easy style, with its frequent touches of humour, and the clearly explained illustrations, make pleasant reading and a valuable addition to a naturalist's library. The concluding chapter is a vindication of the work of Sir Ronald Ross in unravelling the true life-history of the malarial parasite.

J. D. C.

The Polynuclear Count.—By W. E. COOKE, M.D., and ERIC PONDER, M.D., D.Sc. 1927. xiii, 79 pp., 26 plates and text-figs. Published by Charles Griffin & Co., Ltd., 42, Drury Lane, London, W.C. 2.

In 1914 Dr. Cooke published "The Arneth Count," in which he discussed that classification of the neutrophil polymorphonuclear leucocyte according to the segmentation of the nucleus which had been introduced by Arneth some ten years previously. As this work has long been out of print, and as a considerable mass of new clinical and experimental material had accumulated, Dr. Cooke enlisted the able co-operation of Professor Ponder, and the previous volume was

considerably altered and amplified. The old name of "The Arneth Count" has been discarded, for while the authors give full credit to Arneth for his work, his method is so complicated that radical alterations were requisite to enable it to be readily applied to clinical and, indeed, experimental investigations. Schilling has also modified the original Arneth Count, and his method is widely used in Germany, but it differs in several particulars from Cooke's, and we are of the opinion that its application is not so wide. The manner of making the polynuclear count is to classify a population of neutrophil polymorphs (usually one hundred) into five groups having from one to five lobes in the nucleus. When this result is required as a single figure, the method of weighted means is employed and a suitable index for statistical considerations is thus obtained.

It is not possible to discuss the data or the reasoning fully here, but the authors conclude that the polynuclear count makes an accurate study of the reaction of the bone marrow to pathological or other stimuli, possible to an extent which cannot be obtained otherwise. In this conclusion we believe they are fully justified, and their hypotheses concerning the production and life-history of the polymorph appear to fit the facts in the most economical and comprehensive fashion. The polynuclear count, as a part of the clinical investigation of the blood, would seem to have such importance that no hæmatological report which lacked it could be considered complete. In addition to this, however, it provides an open and simple avenue of research into the physiology of the blood and of blood-forming tissues, and the avenue is one which stretches much further than we can see at present.

The latter part of this little book treats of an interesting pathological leucocyte, the macropolycyte, or, as it has also been called, megakaryocyte or pleocaryocyte. The macropolycytes are large cells, which the authors divide into two types: I. is identical in staining reactions to the ordinary polymorph, but the cells are 14 to 21 microns in diameter, and frequently show hypersegmentation of the nuclei, and II., which is the megakaryocyte type, approximating in size and nuclear configuration to the megakaryocytes of the marrow.

In addition, there are appendices detailing staining methods, and figures for the normal polymorph count, and also a bibliography. The book is small, but its importance must not be gauged by its size. It contains a great deal of new and valuable information, and is extremely suggestive; we do not exaggerate when we say that no one interested in hæmatology, whether from the clinical or experimental point of view, can well afford to be without it. W. P. K.

Canadian Fungi.—H. T. GÜSSOW and W. S. ODELL (Mushrooms and Toadstools: An Account of the More Common Edible and Poisonous Fungi of Canada. *Ministry of Agriculture, Ottawa*, 1927, pp. 274 and 128 pls.).

This book is not intended as a treatise on the subject, but as a help to those who wish to become familiar with the larger forms which they are likely to meet with on country rambles. Although the book deals mainly with Hymenomycetes and Gasteromycetes, a few of the more striking Ascomycetes are also described. The species mentioned are accompanied by numerous excellent photographs showing the distinguishing characters of the fungi.

At the end of the book are several chapters devoted to such subjects as the preparation of mushrooms for the table, the poisoning due to fungi, and the artificial cultivation of mushrooms.

The book is intended for students living in Canada, but it will be found equally valuable to anyone in this country who is interested in the subject, and the extremely low price of \$1.00 should make it within the reach of all. W. R. I. C.

PROCEEDINGS OF THE SOCIETY.

AN ORDINARY MEETING

OF THE SOCIETY WAS HELD AT 20 HANOVER SQUARE, W.1, ON WEDNESDAY,
DECEMBER 21ST, 1927, DR. JAMES A. MURRAY, M.D., F.R.S., PRESIDENT,
IN THE CHAIR.

The Minutes of the preceding Meeting were read, confirmed, and signed.

Donations were reported from :

H. T. Güssow—

“Mushrooms and Toadstools.” (Güssow & Odell.)

Royal Bohemian Society of Sciences—

“Structure and Development of the Living Matter.” (Vejdovsky.)

Dr. W. E. Cooke—

“The Polynuclear Count.” (Cooke & Ponder.)

Votes of thanks were accorded to the donors.

The Death was reported of :—

Albert Henry Tuttle. Elected 1882.

A vote of condolence with the relatives was passed.

The President reported that the late Mr. H. H. Mortimer had bequeathed to the Society the sum of Fifty Pounds, which had been duly received.

The List of Fellows nominated for Election at the Annual Meeting in January as Officers and Members of the Council was read.

The President read By-Laws 36-42, pertaining to the Election of Officers and Members of Council.

The following papers were read and discussed :—

Dr. W. J. Elford, B.Sc., Ph.D.

“ The Principles of Ultrafiltration.”

Dr. G. S. Sansom, D.Sc., F.R.M.S.

“ Origin of Giant Cells in the Placenta.”

Votes of thanks were accorded to the authors of the foregoing papers, and to Messrs. Ogilvy & Co. for the loan of microscopes.

The President announced that the Annual Meeting of the Society would be held on January 18th 1928, for the Election of Officers and Members of Council for the ensuing year, and the delivery of the Presidential Address.

The business proceedings then terminated.

THE ANNUAL MEETING

OF THE SOCIETY WAS HELD AT 20 HANOVER SQUARE, W.1, ON WEDNESDAY, JANUARY 18TH, 1928, DR. JAMES A. MURRAY, M.D., F.R.S., PRESIDENT, IN THE CHAIR.

The Minutes of the preceding Meeting were read and confirmed.

New Fellows.—The following were balloted for and duly elected Ordinary Fellows of the Society :—

Laurence Osborne Davis.

Magan Desai.

Percy Phipps Gomersall.

Charles Goosmann.

Ernest George Miller.

L. N. Rao, M.Sc.

M. Sayceduddin, B.Sc.

Reginald Wagstaffe.

The nomination papers were read of the following candidates :—

Walter James Parr, Melbourne.

Reinhard A. Wetzel, New York.

John Walter Shackle, London.

Donations were reported from :

Messrs. Ernest Benn, Ltd.—

“Hunting Under the Microscope.” (Shipley.)

Messrs. Oliver & Boyd—

“The Species Problem.” (Robson.)

Votes of thanks were accorded to the donors.

The Death was reported of :—

Mr. George D. Neill. Elected 1924.

A vote of condolence with the relatives was passed.

The Annual Report of the Council for the year 1927 was read as follows :—

FELLOWS.

Since the last Annual Meeting the Society has lost by death seventeen Ordinary Fellows and two Honorary Fellows, seventeen have resigned, and fifteen have been removed from the Roll.

The Deaths reported are as follows :—

Mr. M. J. Allan. Elected 1913.

Mr. Albert Ashe. Elected 1909.

Mr. Walter Bagshaw. Elected 1909.

Mr. H. G. Billingham. Elected 1912.

Mr. Thomas W. Cowan. Elected 1875.

Dr. C. Da Fano. Elected 1920.

Mr. Walter Dixon. Elected 1896.

Mr. William Fotheringham. Elected 1917.

Dr. G. C. Karop. Elected 1885.

Mr. A. Bolles Lee. Hon. Fellow, elected 1897.

Dr. J. Rudd Leeson. Elected 1914.

Mr. Albert D. Michael. Hon. Fellow, elected 1877.

Mr. H. H. Mortimer. Elected 1918.

Mr. George Potter. Elected 1867.

Mr. Percy E. Radley. Elected 1898.

Dr. F. Shillington Scales. Elected 1898.

Mr. John Stuart. Elected 1871.

Mr. Albert Henry Tuttle. Elected 1882.

Mr. George Watts. Elected 1919.

During the year thirty-two Fellows have been elected, and one has been reinstated.

JOURNAL.

The alteration in the size and form of the Journal has been very favourably received, and the list of subscribers thereto has been considerably increased.

The thanks of the Society are due to the acting Editor, Dr. G. M. Findlay, for his services during the year.

LIBRARY.

The Librarian reports that during the year eighty-five volumes have been borrowed from the Library, and three volumes have been obtained from Lewis's Library.

Donations have been received from :—Messrs. Adlard & Son, Ltd., Mr. S. C. Akehurst, The American Journal of Hygiene, Messrs. Baillière, Tindall & Cox, Trustees of the British Museum, Dr. P. G. Charpentier, M. Paul Lechevalier, The Chicago Academy of Sciences, Mr. Jacob Dynwad, Messrs. Gaston, Doin et Cie, Dr. M. W. Littlewood, Messrs. Longmans, Green & Co., Messrs. Macmillan & Co., Ltd., Messrs. Oliver & Boyd, Messrs. George Routledge & Sons, Ltd., Dr. Sanchez Y. Sanchez, Société Portugaise des Sciences Naturelles, Messrs. Urban & Schwarzenberg, Messrs. Carl Zeiss Ltd., and ten volumes have been added by purchase.

Various inquiries have been received, and have been dealt with as well as the disorganised state of the card-index would permit. Much time has been devoted to the latter, and a complete index of all books and papers is now finished. All books loaned are now entered in a register and on slip blocks bearing the press number, title, name of borrower, and other particulars required by paragraph 4 of the Regulations for the Use of the Library. A register is now being kept in which all incoming books and publications are entered as received.

Abstractors will in future be asked to draw the attention of the Librarian to any papers sent to them of special interest, so that these may be suitably bound and passed into the Library.

Much time and labour have been expended in cleaning, regrouping and re-numbering the volumes and checking each book with its index card, as well as examining publications with a view to eliminating those of least interest to the Society. The Library floor has been cleared of a valueless accumulation, thus adding to the seating accommodation and to the general comfort of Fellows.

On completion of the work in hand, the question of a "Subject Index" for the Library, and the issuing of a new Catalogue, will come up for consideration. Also an examination of the books will be made with a view to rebinding or repairing where necessary. Most of the old leather bindings are dry, and many have cracked ; these will receive attention.

The expense of cataloguing and rebinding will be somewhat modified by the receipt of funds from the sale of redundant books.

We are indebted to Mr. David Bryce for the proper arrangement of the Rousselet papers on the Rotifera. These in due course will be bound and available for reference.

The grouping of the books referred to involved a considerable amount of heavy work, many hundreds of volumes having to be moved. Extra help was needed, and our thanks are due to Mr. Bestow, Mr. Soar, Mr. Richardson and Mr. Thomas for rendering assistance.

The Society's appreciation and thanks are due to the Library Committee—Mr. C. H. Caffyn and Mr. E. H. Ellis—and to Dr. Tierney for the valuable and generous help they have given during the year.

INSTRUMENTS AND APPARATUS.

The Curator reports that there have been no accessions during the year. Work on the catalogue of instruments in the Society's collection has proceeded steadily, and the final proof of this has now been passed for press. It is hoped that copies will be on sale during February or March. As stated previously, the scope of this book has been much increased by including an historical survey of the early progress of optical science, with a complete catalogue of the Society's microscopes and accessories with full descriptions.

Special thanks are due to Mr. A. N. Disney and Mr. C. F. Hill for their unremitting labours to make this work a success.

SLIDE CABINET.

The Curator reports that twenty-one slides have been borrowed from the Cabinet during the year, and that a collection of miscellaneous slides, the property of the late Mr. E. B. Brayley, has been presented to the Society by Dr. M. W. Littlewood.

MEETINGS.

Nine Ordinary Meetings have been held and have been well attended.

The Biological Section continues to maintain its good attendance and interest, and the report of the Honorary Secretary is appended herewith.

The Industrial Applications Section has not met during the year, and the Council are considering the desirability of arranging further meetings in the ensuing Session, of which notice will be published in due course.

CONFERENCE AT LIVERPOOL.

At the invitation of the Council of the University of Liverpool and the Civic Authorities, a very successful Conference was held in that city on March 29th, 30th and 31st, which was well attended.

The thanks of the Council have been accorded to the Lord Mayor, Sir Frederick Bowring, J.P., and the Lady Mayoress, the University Authorities, the Local Committee, and to Professor J. McLean Thompson, who acted as Local Honorary Secretary, for the generous welcome accorded the Fellows and Delegates attending the Conference, a welcome which contributed in no small measure to its success.

THE ANNUAL REPORT OF THE BIOLOGICAL SECTION WAS READ
BY PROFESSOR R. RUGGLES GATES AS FOLLOWS:—

The session 1926-27 marked the nineteenth year of the activities of the Section. The monthly meetings were well attended, and many papers and demonstrations of interest were presented. Among them may be mentioned a description, with lantern, of the nuclear structure of a trichonymphid flagellate, *Holomastigoides hemigynum*, by Professor D. L. Mackinnon; a demonstration and discussion of stereophotomicrographs by Dr. J. A. Murray; an account of the chromosome arrangements in the pollen mother-cells of various species of *Oenothera* by Miss F. M. L. Sheffield. Dr. Ludford gave an account of the physiological

histology of the mammalian ovary, exhibited mitochondria in the oögenesis of *Lumbricus* and described acrosome formation in the testis of a rabbit. Mr. M. T. Denne showed giant leucocytes and migratory spermatozoa in *Lumbricus*, and their significance was discussed. He also exhibited an improved method for paraffin embedding. Mr. D. Bryce described a new species of marine bdelloid Rotifer, and Mr. W. C. Crawley a method of adapting tube length correction to the high-power binocular microscope. Mr. E. H. Ellis showed sections of seeds of *Pyrola*, *Chlora* and *Monotropa* with mycorrhiza. Mr. C. G. Hentschel gave an illustrated account of the correlation of the life-history of the acephaline gregarine, *Gonospora*, with the sexual cycle of the host. Mr. S. C. Akehurst exhibited *Eudorina elegans* and *Chlamydomonas* with fungus parasites attached, as well as preparations showing the detailed structure of the ciliary apparatus in *Volvox aureus*, and the beaded appearance of the flagella and protoplasmic threads on certain aquatic Chlorophyceæ. Mr. D. J. Scourfield exhibited a species of *Volvox* without protoplasmic connections between the cells, and also the red snow organism. Dr. E. W. Howell described the radula of *Arion*. Professor Gates showed a collection of Cyanophyceæ which he made at Khibiny in Russian Lapland.

Messrs. Watson & Sons, Messrs. Ogilvy & Co., and the Laboratory Equipment Co., kindly loaned microscopes for a number of these demonstrations.

Mr. C. Beck moved, and Mr. E. Maurice seconded: "That the Annual Report be received and adopted." Carried.

Canon G. R. Bullock-Webster moved, and Mr. C. H. Oakden seconded: "That a very hearty vote of thanks be tendered to the Officers and Members of the Council for their services during the past year."

Carried unanimously.

Dr. J. A. Murray responded.

THE ELECTION OF OFFICERS AND COUNCIL.

The President appointed Mr. Pledge and Mr. Taverner to act as Scrutineers, and afterwards declared the result of the ballot for the Election of Officers and Members of the Council for the ensuing year as follows:—

President.—Joseph E. Barnard, F.Inst.P., F.R.S.

Vice-Presidents.—R. S. Clay, B.A., D.Sc., F.Inst.P.; W. E. Cooke, M.D., F.R.C.P., D.P.H.; J. W. H. Eyre, M.D., M.S., F.R.S. Edin.; James A. Murray, M.D., F.R.S.

Treasurer.—Cyril F. Hill, M.Inst.M.M., A.Inst.P.

Secretaries.—R. Ruggles Gates, Ph.D., F.L.S.; Clarence Tierney, D.Sc., F.L.S.

Ordinary Members of Council.—S. C. Akehurst; J. G. Bradbury; F. W. Rogers Brambell, D.Sc.; J. D. Coales, D.Sc.; M. T. Denne, O.B.E.; E. H. Ellis; G. M. Findlay, M.D.; J. C. Mottram, M.D.; A. S. Parkes, B.A., Ph.D.; J. Rheinberg; E. A. Robins; E. J. Sheppard.

Librarian.—S. C. Akehurst.

Curator of Instruments.—W. E. Watson Baker, A.Inst.P.

Curator of Slides.—E. J. Sheppard.

On the motion of the President, a vote of thanks was accorded to the Scrutineers.

Dr. James A. Murray then delivered the Presidential Address :

“ Staining and Structure.”

Professor R. Ruggles Gates moved : “ That the best thanks of this meeting be accorded to **Dr. James A. Murray** for his Presidential Address, and that he be asked to allow it to be printed in the *Journal of the Society*.”

Mr. A. N. Disney seconded the proposal, which was carried by acclamation.

Dr. Murray responded.

Mr. Joseph E. Barnard, F.R.S., the new President, was then inducted to the Chair, and returned thanks for his election.

The business proceedings then terminated.

AN ORDINARY MEETING

OF THE SOCIETY WAS HELD AT 20 HANOVER SQUARE, W. 1, ON WEDNESDAY, FEBRUARY 15TH, 1928, **DR. JAMES A. MURRAY**, M.D., F.R.S., VICE-PRESIDENT, IN THE CHAIR.

The Minutes of the preceding Meeting were read, confirmed, and signed.

The nomination certificates of the following candidates were read :—

As Ordinary Fellows :—

Alfred Samuel Chanter.

M. A. Fikry, B.A., B.Sc.

J. Walker Wood, L.R.C.P., L.R.C.S. Edin.

As Honorary Fellow :—

Sir Edwin Ray Lankester, K.C.B., M.A., D.Sc., F.R.S., etc., etc.

New Fellows.—The following were balloted for and duly elected Ordinary Fellows of the Society :—

Walter James Parr.

John Walker Shackle, M.R.C.S., L.R.C.P.

Reinhard A. Wetzel, B.S.

Donations were reported from :

Messrs. George Routledge & Sons, Ltd.—

“An Introduction to the Theory and Use of the Microscope.” (Marshall & Griffith.)

M. Fernand Monpillard—

“Macrophotographie et Microphotographie.”

Messrs. G. P. Putnams, Ltd.—

“The Social World of the Ants.” (Forel.)

Bequest.—The Chairman reported that the late Percy E. Radley had bequeathed to the Society his Watson microscope and accessories, Stephenson dissecting binocular microscope, a collection of miscellaneous slides and books on microscopy, which had been duly received.

The Chairman announced the death of Mr. Martin J. Cole, well known to Fellows of the Society as the originator of methods of double staining and as joint author of the handbook “Modern Microscopy,” by Cross & Cole.

A vote of condolence with the relatives of the deceased was passed.

The following papers were read and discussed :

Mr. D. J. Scourfield, I.S.O., F.Z.S., F.L.S., F.R.M.S.—

“A New Type of Aquarium Microscope.”

Professor J. T. Wilson, M.A., LL.D., F.R.S.—

“Description of a Convenient Table for Microscopy.”

Votes of thanks were accorded to the authors of the foregoing communications.

The Chairman announced that the Biological Section would meet in the Library on Wednesday, March 7th, at 7.30 p.m.

The business proceedings then terminated.

JOURNAL
OF THE
ROYAL MICROSCOPICAL SOCIETY.

JUNE, 1928.

TRANSACTIONS OF THE SOCIETY.

V.—A NEW TYPE OF AQUARIUM MICROSCOPE.

By D. J. SCOURFIELD, I.S.O., F.L.S., F.Z.S.

(*Read February 15, 1928.*)

ONE PLATE.

It will scarcely be questioned that it is very advantageous, from some points of view, to watch aquatic microscopic organisms under conditions as nearly approaching their natural surroundings as possible, instead of having to isolate them and confine them in a small quantity of water in little troughs, watch-glasses, live-boxes or similar contrivances. Only in this way, in fact, can we hope to gain a clear and reliable insight into their movements, habits, and ecology—that is, into their relations and reactions to their natural environment, both organic and physical. For practical purposes, however, the nearest approach to natural conditions under which we can watch the majority of such organisms is to observe them in glass aquaria, including under this term tanks, bell-jars, and such-like receptacles, of varying sizes, but containing at least several pints of water.

The attempted examination of microscopic organisms in such aquaria has already led to the introduction of a number of special types of simple and compound microscopes, usually referred to as tank or aquarium microscopes. Most of these work from the *outside* of the aquarium. They are very useful pieces of apparatus and will always remain so, but, since microscopical focal distances are rather limited, they cannot, unless of very low power, be used on objects very far from the exterior, nor can they be used for objects either on the bottom or on the surface. Further, as it is necessary to focus through the sides of the aquarium, the quality and

thickness of the glass become very serious problems if any but low powers are required to be used.

So far as I know, only one aquarium microscope has hitherto been made to work from the *inside* of the aquarium. It was designed by J. W. Stephenson, and is described and figured in the Journal of this Society, 1884, vol. 4, pp. 798-9, also in Dallinger's editions of Carpenter on "The Microscope and its Revelations" (see 7th edition, 1891, pp. 220-1, and 8th edition, 1901, pp. 267-8). Although it is claimed that with this instrument any point of the aquarium can be reached, it seems evident from the description that only more or less oblique, and, therefore, usually distorted, views of objects on the sides could be obtained, and no view at all from below of objects on the surface.

The microscope which is now described is also designed for use inside the aquarium, but, unlike the Stephenson instrument, which was protected from contact with the water by being placed in a glass cylinder, its lower part, including the objective, is immersed in the water. In a sense this method of using a microscope may, of course, be regarded as the logical outcome of the comparatively recent introduction of low and medium power water-immersion objectives, the use of which has been so strongly advocated and practically demonstrated at many meetings of this Society by Mr. Akehurst.

The chief features of the new instrument may be briefly stated as follows: The part of the apparatus on which the microscope is supported and which, for want of a better name, may be called the "bridge," consists of two stout parallel rods securely held in position by cross-bars at their ends. Its length is 13 inches, so as to allow of its being placed on aquaria up to 12 inches across, but it could, of course, be made of greater length if necessary. A movable clamp is provided on each rod to secure the bridge firmly to the aquarium in the position required. Obviously other methods of supporting the microscope could be adopted if desired.

Sliding freely on the bridge is a saddle in the form of a rectangular plate with two of its edges turned down, on which is carried what is to all intents and purposes a mechanical stage with horizontal rectangular rack-and-pinion movements, which, in its turn, carries a rotating sleeve into which fits the body-tube of the microscope. The sleeve is provided with the usual vertical rack-and-pinion focussing arrangement.

In order to be able to bring into focus objects on the bottom of aquaria up to 8 or 9 inches deep, and to allow for the necessary mechanism above water, the tube has been made 10 inches long. It is of the usual 1-inch draw-tube material, but has been chromium plated to resist the action of the water. It can be pushed up and down by hand in the rotating sleeve. A longer tube could evidently be employed if required, but there are, as is well known, limits to length which, for optical reasons, it is not advisable to exceed, unless compensating lenses are introduced.

At the lower end of the body-tube, and with its axis at right angles to it, is fixed a cylindrical casing containing a right-angled prism. In line

with this, and therefore standing out at right angles to the tube of the microscope, is attached a second cylindrical casing also containing a right-angled prism. This second casing acts as the objective carrier, the objective being screwed on at right angles to the axis of the casing. The second casing is capable of complete rotation upon the first in a vertical plane, the junction between the two being made by a water-tight fitting. Rotation is effected by toothed gearing worked by a stainless steel rod from a milled head placed near the eyepiece. Both casings are coated with cellulose black enamel, again with the idea of resisting the action of the water, whether fresh or salt.

It will be seen from the foregoing description that by means of the bridge, which can be laid across the aquarium in any desired direction, combined with the movement of the saddle sliding upon it and the drawing in or out of the tube of the microscope, the objective may be brought into any region of the aquarium. Then, by also using the horizontally rotating sleeve combined with the vertically rotating objective carrier, the objective can be directed towards any object within its "sphere of influence." Finally, focussing adjustments and small traversing motions can be made by means of the three sets of rack-and-pinion movements.

In this way it is possible, theoretically at any rate, to reach and to view from any desired angle every object contained in the water, including such as may be on the surface. These latter can, of course, be viewed from below by pointing the objective upwards. They can also be seen from the side by placing the objective along the surface and raising it about half its diameter out of the water. The line of junction or interface between air and water can then actually be focussed, and with it any object just below or attached to the surface-film. When viewed in this way, such objects appear doubled owing to the effect of the total reflection from the air-water interface. It is quite possible that this method of using the objective may lead to interesting observations on organisms making use of the surface-film, such as *Scapholeberis* and *Notodromas* among the Entomostraca and gnat larvæ among the insects. By using a dry objective and pointing it vertically downwards when the lower end of the body-tube is raised above the water, it is evident that any object on or near the surface can also be viewed from above.

It must be admitted that, owing to the large number of combinations of movements possible with this microscope, it is a little difficult to manipulate, while a certain amount of practice is required in order to be able to use it to advantage; but then this applies in a greater or less degree to all scientific instruments.

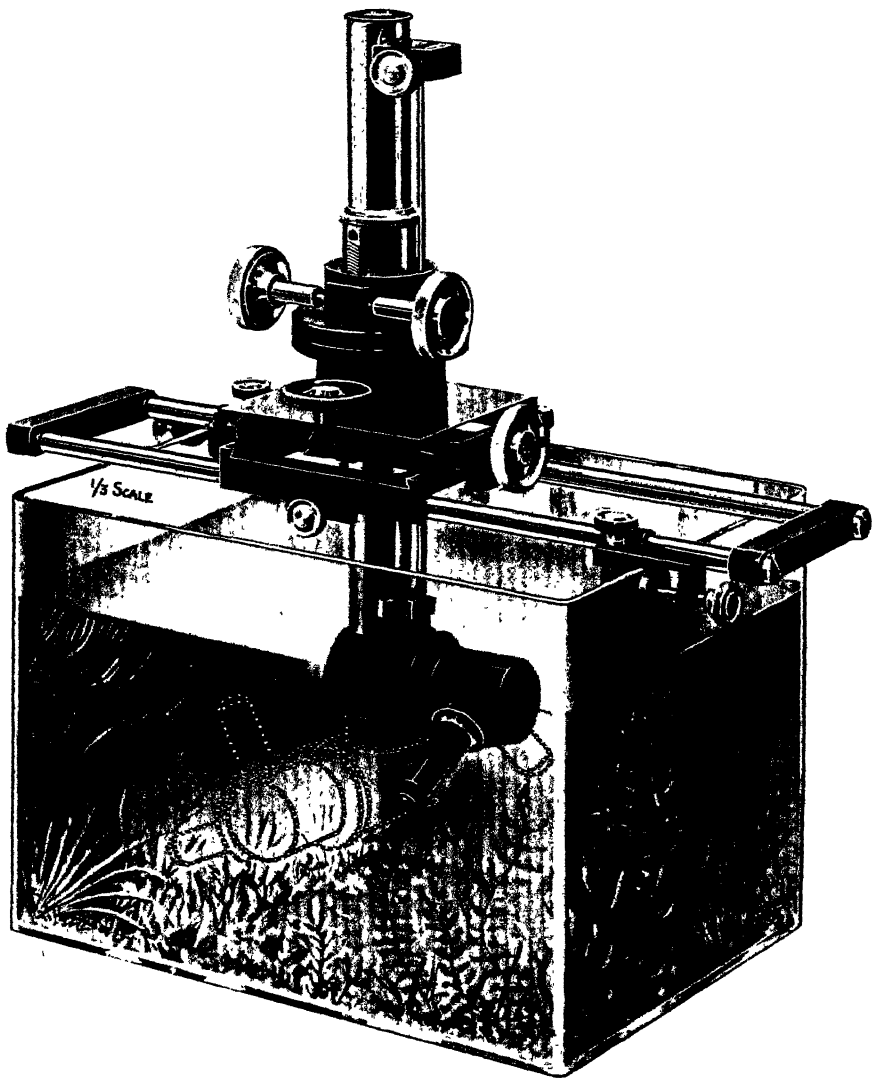
One of the most important factors in the use of this microscope is, no doubt, the illumination. This matter has not yet been sufficiently investigated to allow of any final statement being made as to the best methods to be employed. It can, however, be said that with low powers, say, 2 in. or 1 in. or even $\frac{1}{2}$ in. objectives, there is usually enough light on a bright day

to enable one to work fairly well without any special means of concentrating the light, while on dull days and at night moderately good illumination can, with some care in manipulation, be obtained from an artificial source of light concentrated by means of a bull's-eye or equivalent condenser outside the aquarium. It cannot, however, be expected that these rather elementary methods of illumination will give pictures of microscopic organisms as good as those we are accustomed to see under the microscope used in the ordinary way. Probably it will never be possible to illuminate microscopic objects in aquaria with anything approaching the perfection that can be reached on the stage of a microscope with the help of a suitable substage condenser, but it is hoped that eventually, by means perhaps of the vertical illuminator or some form of Lieberkühn or ring illuminator, or in some other way, it will be possible to improve upon the results so far obtained. In this connection it should be remembered, however, that for the purpose for which this microscope is chiefly intended, namely, the observation of the habits of the living organisms in approximately their natural surroundings, it is not so necessary that the objects should be viewed under the ideal conditions of illumination as it would be for the investigation of their structure.

With regard to the objectives that can be used with this microscope, they should in theory, no doubt, all be water-immersion lenses, but for low-power observations ordinary dry objectives appear to work reasonably well. Up to the present I have used only objectives not exceeding $\frac{1}{2}$ in., and probably the chief value of this instrument will always be for low and medium power work. But as there is nothing between the front lens of the objective and the object but water, there seems no reason why there should be any particular limit to the powers used, except that the question of illumination necessarily becomes more and more difficult as high powers are employed. To prevent leakage of water into the microscope the screw-thread and flange of the objective should be coated with a little vaseline or similar material, and if there is a joint in the mount, the lower part should be unscrewed and its thread and flange treated in the same way. Unfortunately existing objectives, even some of the so-called water-immersion objectives, are by no means watertight, but the makers should have no difficulty in making them so if required.

Although this microscope has been primarily devised for the observation of microscopic organisms in aquaria, there are probably a number of other uses to which it could be put in the study of aquatic problems, and it is just possible that it might be found convenient for use out of water in cases where information was required about the interior of pipes or hollow parts of machinery not easily accessible in the ordinary way.

In conclusion, I would like to express my best thanks to Messrs. Ogilvy for having taken so much pains in constructing the instrument and for the help they have given in the arrangement for its exhibition.



A NEW TYPE OF AQUARIUM MICROSCOPE. 7

(Reproduced by courtesy of Messrs. Ogilvy & Co., London.)

VI.—THE MODE OF FORMATION OF THE IMAGE IN THE MICROSCOPE.

By H. MOORE, A.R.C.S., D.Sc., F.Inst.P.,

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Research Association.

(Read May 16, 1928.)

THREE TEXT-FIGURES.

THE processes which are involved in the formation of the image of a non-luminous object have been the subject of much controversy among microscopists. In recent years, however, papers dealing with the subject have been comparatively rare, while public discussions on the subject have been almost, if not entirely, lacking.

The whole question has been reopened recently in a paper by Professor Berek of Marburg (1926), to which my attention was drawn by Mr. Conrad Beck.

Professor Berek gives a very complete history of the development of the problem and an excellent summary of the views expressed by different writers on the subject. Time has not permitted of my verifying all these, and the historical part of this paper must be taken as part of the account I have been asked to give of Berek's paper.

I have extracted from his paper only those references and views which appear to be essential to the main argument, and have also thought it well to introduce explanatory statements wherever they appeared to be desirable. In doing this, I have not felt bound to use the arguments or elaborations used by Berek or by the original authors whose views he quotes. My object in doing this has been to compress within the limits of one paper a sufficient survey of the essentials of the problem, and at the same time to make the argument as nearly continuous as possible.

The "Equivalence" Theory.—Up to the time when Abbe put forward his diffraction theory of microscopic vision, it was generally accepted that the images of non-luminous objects were formed by processes essentially similar to those involved in the formation of images of self-luminous objects. A non-luminous object was, in fact, considered as exactly "equivalent" to a self-luminous object.

As regards the image in the microscope, the microscope object-glass

was considered to act exactly as any other kind of lens, and such relations as that connecting resolving power with aperture were assumed to be the same for microscope object-glasses as for telescope object-glasses and lenses of all other kinds.

These views were expressed by leading physicists of the day, such as Airy, Arago, Foucault, J. F. W. Herschel and Helmholtz, and, presumably, were held by everyone who gave any thought to the matter. The theory was never proved, nor does it appear to have been even stated in any explicit manner; it was simply assumed on the grounds of experience.

Abbe's "Diffraction" Theory.—When light falls upon objects which have dimensions comparable with the wave-length of light, effects come into prominence which are not usually observed with large objects. These effects give rise to many different kinds of appearances, but they may all be grouped together under the general name of "diffraction effects."

Abbe studied these effects as they are shown by objects seen in the microscope, and as a result of his experimental investigations he put forward his "diffraction" theory of microscopic vision. A brief summary of this will now be given, and, for simplicity, we will imagine that the light used to illuminate the object is monochromatic, of wave-length λ .

When light from a distant source falls perpendicularly on a fine regular structure such as a "transmission" grating, much of the light passes straight on, but a certain amount is diffracted and leaves the grating along directions inclined at definite angles to the directly transmitted beam. If d is the distance between adjacent lines in the grating, the diffracted beams are inclined to the directly transmitted beam at angles $\alpha_1, \alpha_2, \alpha_3$, etc., corresponding to the relations

$$\sin \alpha_1 = \frac{\lambda}{d}, \sin \alpha_2 = \frac{2\lambda}{d}, \sin \alpha_3 = \frac{3\lambda}{d}, \text{ etc.}$$

An object-glass having an aperture large enough to utilise rays inclined at an angle u to the axis will, when focussed on the grating, admit all the diffracted rays for which the angle α is less than u . Each beam entering the object-glass will be brought to focus just behind the object-glass and will give rise to an image of the source. These images will lie approximately in one plane; their number and distribution will depend on the numerical aperture of the object-glass and on the "grating-interval" d .

The light which travels on up the microscope tube from any part of one of these images will interfere with the light coming from the corresponding parts of all the other images. If the images are very small, the interference will be sharp and the interference fringes well defined. The form of the interference "lattice" will depend on the number of images (of the source) formed in the back principal plane of the object-glass. Two such images symmetrically situated with respect to the axis would produce brightness and darkness in alternate surfaces lying along the microscope tube and diverging fan-wise on either side of the axis (fig. 1). Three such images,

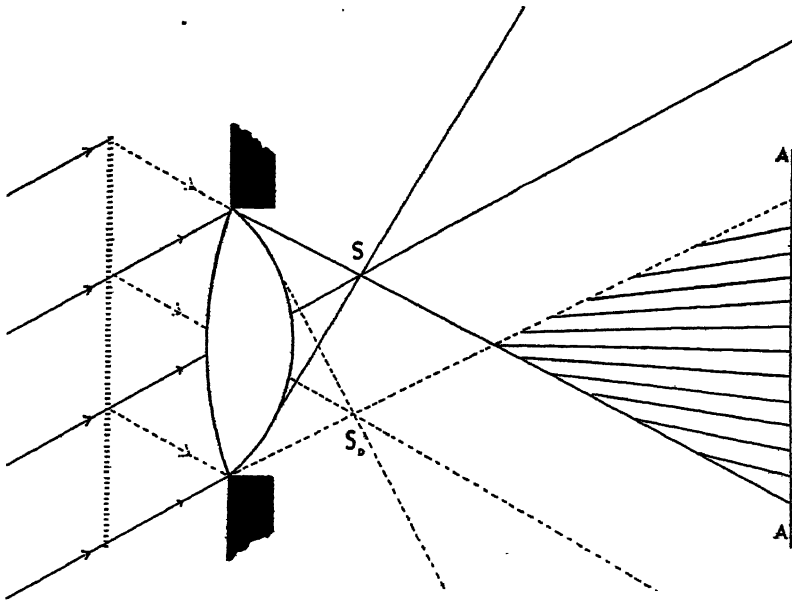


FIG. 1.

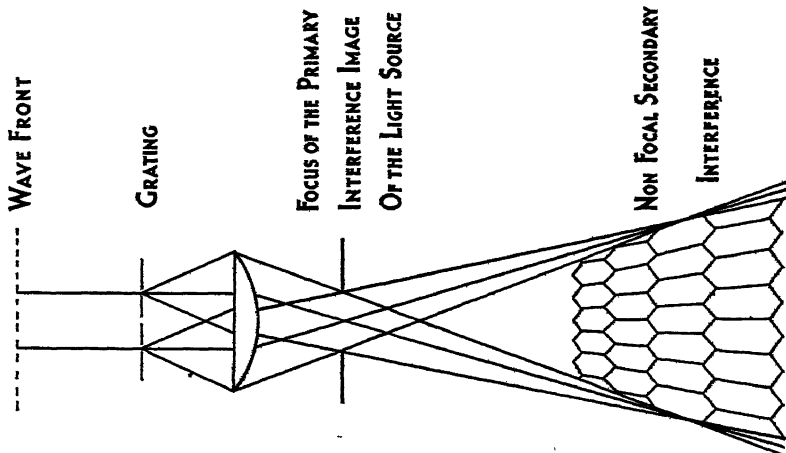


FIG. 2.

with the centre one on the axis and the other two symmetrically situated on opposite sides of the axis, would produce what Berek call a "honeycomb" lattice (fig. 2).

Mr. R. J. Bracey has worked out the form of this lattice for various intensities of the diffracted images in relation to the intensity of the central image, and has drawn for me diagrams which illustrate his results.

Diagrams 3 (A, B, C, D) represent elements of the interference pattern corresponding to a single "cell" of the honeycomb, and indicate the intensity of light in planes lying along the microscope tube when the relative intensities of the three images of the source are as follows:

Diagram.	Relative Intensity of Central Image.	Relative Intensity of each Diffracted Image.
3 A	1	zero
3 B	$\frac{1}{2}$	$\frac{1}{2}$
3 C	1	$\frac{1}{2}$
3 D	zero	1

Diagrams 3 B (α , β , γ) and 3 C (α , β , γ) represent sections of the interference patterns 3 B and 3 C *across* the microscope tube in three representative planes, and so represent elements of the patterns which would be seen in any eyepiece focussed on the corresponding planes.

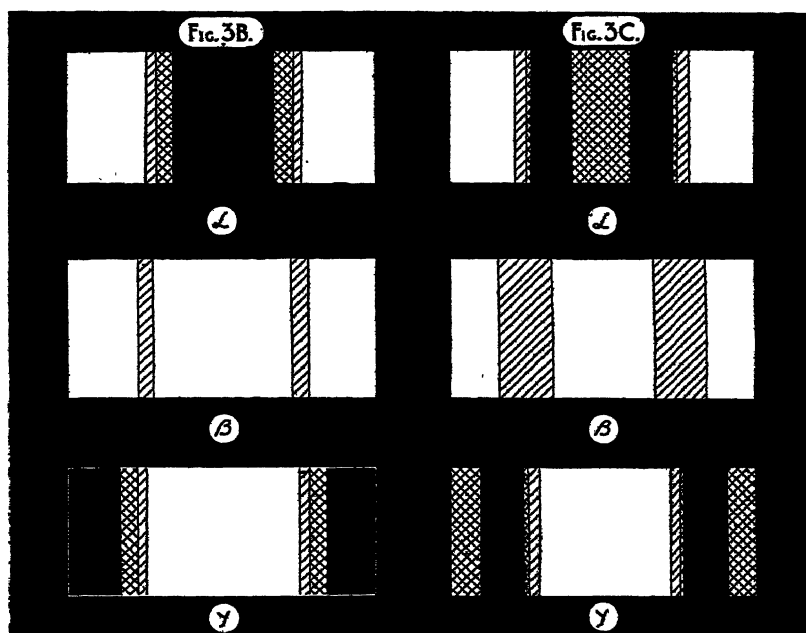
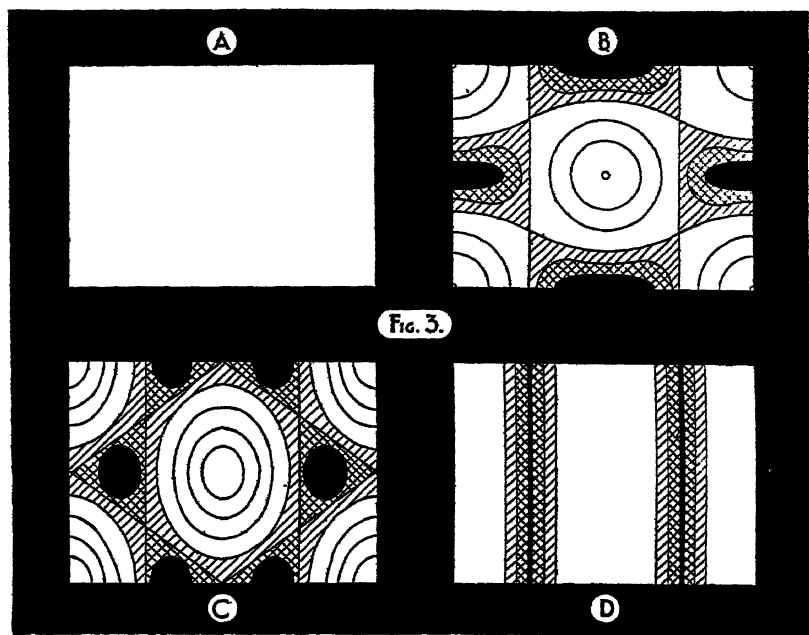
In the case corresponding to 3 A, no pattern would be seen in the eyepiece.

In the case corresponding to 3 D, the pattern seen in the eyepiece would be of the same form as that indicated in diagram 3 D.

For any particular system of images of the source, the form of the interference lattice can be worked out mathematically, and the type of interference pattern which would be produced in any plane such as AA (fig. 1), can be predicted. These appearances can all be verified experimentally.

Abbe studied the types of interference fringes obtained with simple gratings and with gratings ruled across each other at various angles. He also used diaphragms behind the object-glass to admit or cut out the various diffracted beams at will, and studied the ways in which the appearances seen in the eyepiece were thereby modified. As a result, he came to the conclusion that the image in the microscope is produced solely by interference between the light coming from the images of the source which are formed behind the object-glass. The type of interference pattern obtained depends on the number and distribution of the images of the source and, since these are distributed in a manner characteristic of the structure of the object, the type of interference appearance obtained will also be characteristic of the structure of the object. In this restricted sense the interference pattern seen in the microscope can be considered as a representation or "image" of the object, but it cannot be claimed that this interference pattern necessarily bears any true resemblance to the object.

The experimental conditions under which Abbe's experiments were



carried out were (a) the object had a regular periodic structure, and (b) the object was illuminated by a narrow pencil or beam of light consisting of practically parallel rays, corresponding to the use of a cone of illumination of very small angle. Abbe did not limit the applicability of his theory to these particular conditions, however, but claimed that it was of *general applicability for every type of object and for every type of illumination*.

Abbe's theory immediately attracted considerable attention. It was accepted by many almost at once, but there were also many who rejected the new theory and who held to the older views which have been described earlier under the name of the "equivalence" theory. It will be convenient here to give brief references to the more important of the contributions to the discussions which took place during the controversy which arose out of the publication of Abbe's theory.

On practical and experimental grounds the issue centred mainly round the question of methods of illumination. Abbe's theory points to the use of a narrow cone of small angle as the type of illumination to give the closest resemblance between the image and the object, since, with such a cone, sharp, clear interference patterns are formed in the body-tube of the microscope. A cone of larger angle gives a medley of interference patterns which cannot coincide with each other since they have not a common spacing interval. As a result, the "image" (i.e. the interference pattern) formed when a cone of appreciable angle is used, is blurred and less definite than that obtained with an illuminating cone of very small angle.

Many microscopists held the view that illumination with a cone of very small angle is precisely the one to be avoided if the closest possible resemblance between the image and the object is to be obtained. Among those who put forward these views prominently, mention may be made of R. Koch in Germany (1878) and Lewis Wright and E. M. Nelson in this country (1894-5). Lewis Wright's opinions as to the processes involved in the formation of the image in the microscope were strongly emphasised by the clear demonstrations given by E. M. Nelson of the superiority of the images obtained with wide-angle illumination as compared with those obtained with narrow pencils. Special reference to Lewis Wright's views is contained in Nelson's Presidential Address to this Society in 1895, in which he expresses entire agreement with these views.

An attack of a more direct character was made by R. Altmann (1880). Altmann stated that, by using diaphragms similar to those which Abbe had used behind the object-glass, the results which Abbe had obtained with illuminated non-luminous gratings could be reproduced if a hot-wire (self-luminous) grating were used. If this were so, the value of Abbe's experiments as evidence supporting his theory would be seriously discounted, since Abbe had based his explanation of these results on the existence of the regular persistent interference which occurs when an illuminated grating is used, and such interference could not occur with a self-luminous grating. Mandelstam (1911) described some experiments.

which he had carried out with hot-wire gratings, and confirmed Altmann's statements.

On theoretical grounds the exponents of the equivalence theory were at a serious disadvantage. The most satisfactory procedure would have been to have put forward a rigid mathematical treatment of the problem as it arises when a cone of illumination of appreciable angle is used. To give such a treatment, however, involves, first of all, the finding of an expression to represent the vibrations which originate at a simple point source such as a single light-emitting atom. This expression must be of such a type as to satisfy all that we know of the nature of light in relation to the conditions under which interference can and cannot occur, and the development of such an expression is a matter of considerable difficulty.

In default of such an expression, any attempt to give a mathematical treatment of the composite vibrations in a cone of illumination of finite angle was out of the question, and the only line of attack which could be followed by the exponents of the equivalence theory was to question the applicability of Abbe's theory to conditions of illumination other than those which obtained in Abbe's experiments. The late Lord Rayleigh considered the conditions which arise when an object is illuminated by a cone of wide angle (1896). He showed that if two adjacent details in the object are separated by a distance s , the light falling on these will consist of substantially identical vibrations, provided s is very small compared with the quotient λ/A , where A is the half-angle of the condenser cone. Otherwise the vibrations will be sensibly independent of each other.

The result which Lord Rayleigh obtained can be deduced in a sufficiently exact manner as follows: The condenser is supposed to be adjusted so that an image of the source is focussed in the plane of the object. If we consider a single luminous point in the source, the image of this will be a bright "diffraction disc" surrounded by concentric bright and dark rings, the intensity of the bright rings being small compared with that of the disc. The diameter of the disc will be equal to $1.22 \lambda/\sin A$. The light-vibrations falling within this disc will all be closely related, i.e. will be "coherent."

Now imagine that the source consists of *discrete* luminous points separated by such distances that the diffraction discs in the image formed by the condenser are just completely separated. The object would then be illuminated in circles of diameter $1.22 \lambda/\sin A$, each circle being surrounded by diffraction rings of relatively feeble intensity. Over each circle the vibrations would be coherent, but the vibrations in adjacent circles would have nothing *persistently* common except their wave-length and vibration-frequency, i.e. the vibrations in adjacent circles would be non-coherent.

Under actual conditions, with a *uniformly* luminous source, coherence does not extend over any large proportion of the area covered by any single diffraction disc, owing to the overlapping of other discs. Without closer argument, therefore, we can deduce that coherence cannot, under these conditions, extend over an area which is any large proportion of the area

of a single diffraction disc. Actually the area over which the light has any large measure of coherence is very small compared with the area of a diffraction disc.

This means that if two points in the object are separated by a distance which is *not* small compared with the diameter of the diffraction discs formed by the condenser, the light vibrations reaching those points, and subsequently "re-emitted" by them, are practically independent of each other. The light leaving these points thus resembles that which would be emitted by two independent self-luminous sources, insofar as the absence of persistent amplitude- and phase-relationships is concerned. Now, if two details in an object can be just *completely* resolved by a particular object-glass, the distance separating them must be equal to $1.22 \lambda / n \sin u$, where $n \sin u$ is the numerical aperture of the object-glass. This is exactly the same as the diameter of the diffraction discs formed by the condenser if

$$\sin A = n \sin u$$

i.e. if the condenser is opened wide enough just to "fill" the object-glass aperture. With such a condenser aperture, therefore, the images of these two details could not be formed by any interference processes, since the light coming from the two details is non-coherent. The images of these points must, therefore, be formed in exactly the same way as the images of two self-luminous points, if they are to be formed at all.

Lord Rayleigh's paper appears to have attracted very little attention. At all events, its influence does not seem to have been widespread.

Many years before Lord Rayleigh's paper was written, Verdet (1881-1883) had published some results which can be reduced to a form similar to that in which Lord Rayleigh's result was expressed, though Verdet considered the light falling on the object to be direct radiation coming from an extended source and not through a condenser.

Time does not permit of descriptions of the theoretical investigations made more recently by L. Mandelstam, Wolfke, and von Laue, all of which led to conclusions of the same type as that obtained by Lord Rayleigh.

Papers dealing with developments of, and deductions from, Abbe's theory have appeared occasionally. Among these only one need be referred to here, and that is an article by Cross (1912) dealing with the resolution obtainable when dark-ground illumination is used. According to the Abbe theory, the resolution obtainable with any dry-front lens cannot exceed that corresponding to N.A. 0.5 when dark-ground illumination with a "dry" condenser is used. At the time when Cross pointed this out it was known by many microscopists that the resolution obtainable with dark-ground illumination is in no way inferior to that obtained with transmitted light, so that in this matter, at any rate, the Abbe theory appeared to be at fault.

Mr. Conrad Beck, in his book on the microscope (1924), drew attention to the fact that "anything that can be resolved by transmitted illumination

can be resolved by dark-ground illumination, and in general with much greater brilliancy, because of the increased contrast between different parts of the structure," and at about the same time Professor M. Berek also pointed this out in a communication to the "Zentral-Zeitung für Optik und Mechanik." Since then Professor Berek has published the paper from which much of the subject-matter of this present paper is extracted. In addition to the historical references in Berek's paper, a novel theoretical treatment of the mode of formation of the image in the microscope is given. To this some reference must now be made, though to do anything like justice to it another paper, at least the length of this one, would be necessary.

Berek puts forward the view that whenever the distribution of light in a particular plane is uniform, so that no signs of interference can be detected, the light coming from that plane can be considered as entirely "dissonant" (non-coherent), as it would be if the plane were self-luminous. If, however, there is any evidence of interference in the plane in question, there is a certain measure of "coherence" in the light passing through that plane. Berek uses the term "consonance" instead of coherence, and suggests a method of expressing quantitatively a property of the light which he calls the "degree of consonance."

The degree of consonance can have values ranging from zero up to unity. The zero value represents fully *dissonant* light, while the value unity represents fully *consonant* light. When the light reaching the object-glass is fully consonant, the image of the object is formed solely as a result of interference, i.e. in accordance with Abbe's theory. If the light entering the entrance pupil of the object-glass is fully dissonant, the image of the object is formed exactly as though the object were self-luminous. Berek has worked out a number of interesting examples on this theory, but time will not permit of dealing with these nor with his theory in any detail.

It is necessary now to consider the position in the light of the evidence which has been put before you. We have only two theories to deal with. If it can be shown that, under any particular conditions, one of these theories gives a complete explanation of the whole of the appearances seen in the image and image-space, the other theory cannot be applied when those particular conditions obtain. Alternatively if, under any particular conditions, one of the theories is shown to be inapplicable, the other theory must, in default of any third theory, be considered to stand.

Now, Abbe's theory undoubtedly gives a complete explanation of the appearances seen when the object has a regular periodic structure and is illuminated by a pencil of practically parallel rays or by a "cone" of very small angle. The "image" has no true focus-plane, and such variations as can be seen when the eyepiece is moved up or down in the body of the microscope (without moving the object-glass relative to the object) can all be predicted if the positions of the images of the source, which are formed behind the object-glass, are known. The "image" seen in the eyepiece is not a true image of the object except in so far as the term "image" can be applied

to an interference pattern the exact form of which is determined by the structure of the object.

Abbe's theory is not applicable when the cone of illumination is large, and no proof of its applicability under these conditions has ever been given. It is unsound to draw deductions from observations made under particular conditions and to conclude that these deductions are generally true under all possible conditions. The conditions on which Abbe's theory is based, and the conditions which he arranged in his experiments, are particular in two respects, viz., the use of a very narrow cone of illumination and the use of an object having a regular periodic structure. So far as I know, it is on this evidence, and on this evidence alone, that the Abbe theory and the claim of *general applicability* of this theory are based.

Some eight or nine years ago I made several attempts to substantiate the Abbe theory when cones of wide angle are used. Sir Herbert Jackson had outlined the theory to me while he was giving me my first introduction to serious microscopy. He had demonstrated its undoubted applicability when illumination with a narrow cone was used, but had said that he could not accept it as applying under conditions of illumination in which wide cones were employed or when dark-ground illumination was used. Sir Herbert Jackson also said that he was unable to consider the action of a microscope object-glass as being in any way different from that of an ordinary telescope object-glass for camera lens, and that, in his opinion, whatever theory held for the one must hold for the others.

My reason for attempting to prove the Abbe theory, instead of attempting to disprove it, was that I wanted to find the strength or weakness of this theory. The truth of the theory for narrow cones was easily demonstrated, but in whatever way I attacked the problem of the "wide-angle" cone I found it impossible to make headway, even if I made such assumptions as to the nature of light as would require *any* two radiations of the same wavelength to interfere regularly and persistently even if they originated from two different sources. Among the conclusions which came out of my investigations was one which corresponded, in essence, to that already referred to as having been obtained by Lord Rayleigh. In the end I gave up the attempt to substantiate Abbe's theory, and came definitely to the conclusion that it could not hold for illumination with cones of wide angle.

The positive evidence in favour of the equivalence theory has already been briefly outlined. Lord Rayleigh's result is, in itself, sufficient evidence that the equivalence theory is much nearer to the truth, under ordinary conditions of illumination, than Abbe's theory. The rest of the evidence, both theoretical and practical, so amply confirms this deduction that it can be fairly claimed that under the conditions of illumination most commonly employed, the mode of formation of the image in the microscope is, in the main, the same as the mode of formation of the image of a self-luminous object.

REFERENCES.

- ALTMANN, R.—(1880). *Archiv. für Anat. und Entw. Anat. Abt.*
BECK, C.—(1924). *The Microscope*, 2, 125.
BEREK, M. PROF.—(1926). *Marburger Sitzungsberichte*. (Read 8th December, 1926.)
CROSS, M. I.—(1912). *Knowledge*, No. 37.
KOCH, R.—(1878). Berek.
MANDELSTAM, L.—(1911). Quoted by *Annalen der Physik* 4, 35, 881-897.
NELSON, E. M.—(1895). *J.R.M.S.*
RAYLEIGH, BARON—(1896). *Phil. Mag.* 42, 167-195, also (1903), *Scientific Papers*, IV.
VERDET, E.—(1881-1883). *Lecture on the Wave Theory of Light*. German translation by K. Exner, Brunswick.
WRIGHT, LEWIS—(1894). *English Mechanic and World of Science*, 60, Nos. between 1537 and 1547.

VII.—SOME INTRODUCTORY EXPERIMENTS DEALING WITH
A QUANTITATIVE METHOD OF DETERMINING THE
RESOLVING POWER OF MICROSCOPE OBJECTIVES.

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(*Read April 18, 1928.*)

TWO PLATES AND ELEVEN TEXT-FIGURES.

SINCE Abbe's time it has been realised that the possible resolving power of a microscope objective may be increased in either of two ways, namely, by increasing its numerical aperture or by decreasing the wave-length of the light with which it is used. The aperture of such lenses had been pushed, even forty years ago, to very nearly its physical limit, and it was considered that a reduction in wave-length of the light employed would, presumably, give a still higher possible resolution. It was not altogether surprising, therefore, that some twenty-five years ago there became available apparatus* for use in ultra-violet radiation, including the entire optical system of the microscope in quartz; but owing to the (apparent) lack of technique in this subject, and to the extraordinary difficulties involved in the manipulation of the apparatus, ultra-violet microscopy seemed to receive a setback for many years, and consequently did not develop as might have been expected.

With an increase in knowledge of optical matters, however (gained during this period of years), the subject has again been taken up, and attempts are being made to make the ultra-violet microscope of real technical utility. The title of this paper is the outcome of some work carried out by the writer in a modest attempt to aid, if possible, the renewed efforts that are being made in this direction.

It seemed that one of the essential things to obtain in this work was a means whereby it would be possible to tell what a given objective would really resolve; in other words, a means of obtaining a quantitative rather than a qualitative test on the performance of the lens. Thus an actual figure could be stated for an objective and, provided the method could be used for ultra-violet illumination, a direct test could be applied to determine whether increased resolution really was being obtained by using light of a shorter wave-length.

* By Carl Zeiss, Jena.

With this ultimate aim in view, it was decided, first of all, to attempt to develop such a method by using ordinary objectives in visible light, and the following methods described were the first steps in this direction:—

The ruled grating at once suggested itself as being a suitable test-object for this work, but the fact of choosing a grating which would just cease to give resolution by a given lens would necessitate employing a large number of gratings of different rulings. Such a scheme, besides being a highly expensive one, has little in its favour and would be entirely unpractical.

It occurred to the writer that if the object could be varied in size whilst under observation, and that if the separation interval could be known at any instant, this would form a convenient method of determining a numerical value for the limit of resolution of the objective. To this end the following method was suggested—briefly, it consisted in projecting the image of a grating (of relatively coarse rulings) by means of an auxiliary optical system, and observing this image with the objective under test. The grating itself is mounted on a rotating table, the angular movement of which can be measured, and therefore the apparent distance between the lines of the imaged object varied.

The idea of projecting a minified image in the object plane of a microscope objective is not new, as references show an account of such a method given by J. J. Lister (1837) and later by Harting (1866). In the former's method an "image of small squares or stripes were formed by means of a short focus lens," and the size of the image thus produced was varied by altering the distance between the object and lens. A possible objection to this method is the fact that aberrations would be introduced by a variation of the object distance from the lens concerned, and thus the definition of the image would suffer as a result of this. Von Harting used small air bubbles in water to form a reduced image of an object, and employed this image for observation with the microscope. The aberrations here introduced by a spherical bubble, or what was in all probability a flattened sphere due to the contact of the bubble with the underside of the cover glass, would again result in an accompanying loss of definition in the image.

In the experiments to be described, the idea of using a minified image to act as the object was also employed, but the modification of rotating the grating had the advantage of not seriously adding to the aberrations of the object-forming lens; moreover, the reduced image was produced by a well-corrected optical system (namely, a microscope O.G.) with the grating situated at the correct tube-length of the objective.

The method was divided into two sets of experiments, one in which an auxiliary objective was used to form the "object" for the lens under test, and one in which the objective under test served at its own object-forming lens, that is, by applying the method for use with a vertical illuminator. The results and conclusion of the work form the subject of the paper.

THEORY OF METHOD.

The formation of a reduced image produced by a lens system when the object is rotated, will be readily remembered by reference to fig. 1. Lateral and axial magnifications being proportional to M and M^2 respectively, it follows that the axial length l' of the minified image $a'b'$ will be equal to $\frac{l}{M^2}$, and therefore will be distinctly small in comparison with l . Providing l' is less than the depth of focus of the lens to be tested, the image $a'b'$ acts as a sensibly flat object, and the spacing of the lines of this imaged object will be proportional to the cosine of the angular swing of the grating ab .

The depth of focus of an objective being $\frac{\lambda}{4 \cdot n \cdot \sin^2 \frac{U}{2}}$, it will be seen that in order to prevent l' exceeding this depth of focus, a necessary limit is imposed on the maximum permissible rotation of the grating; therefore it is desirable to choose a suitable grating such that resolution will cease (for the lens under test) before the grating reaches this maximum angular

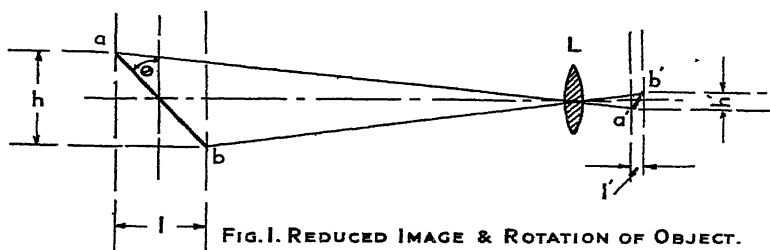


FIG. 1. REDUCED IMAGE & ROTATION OF OBJECT.

position. Also it is necessary to limit the field in which the imaged grating lines are formed—in this case being done by a line ruled on a silvered cover glass.

EXAMPLE :—

If L is assumed to be a $\frac{1}{4}$ -in. objective giving a minification of 40 times, and if the length of the actual portion of the grating used ab was 2 mm., and further, supposing that it is rotated through an angle of 60° , then it will be found that l' is equal to .0011 mm.

If a $\frac{3}{8}$ -in. objective were to be used to view this image, then its depth of focus = $\frac{\lambda}{4 \cdot n \cdot \sin^2 \frac{U}{2}} = .0064$ mm. Thus l' is well within the permissible value for producing a "flat" object for the $\frac{3}{8}$ -in. lens under test.

If the lens under test was to be a $\frac{1}{4}$ -in. O.G., its depth of focus = .00086 mm., therefore the grating could not be rotated as far as in the first case; consequently a more closely ruled grating would have to be employed, so that resolution ceased well before this angle was reached.

On this principle, therefore, from a knowledge of the size of the grating space in the imaged object when the grating is normal to the optical axis, and by determining the angle at which resolution of the lines just cease, it would be possible to obtain a numerical value for the resolving power of a

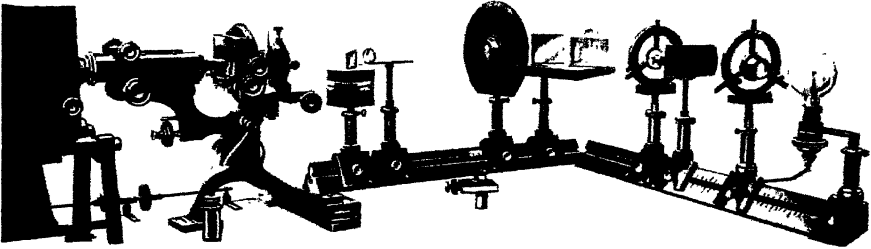


FIG. 2.—General view of apparatus.

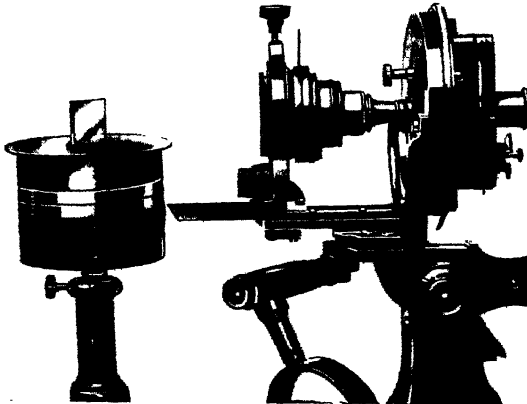


FIG. 8.—Auxiliary objective in substage mount with grating on rotating table.

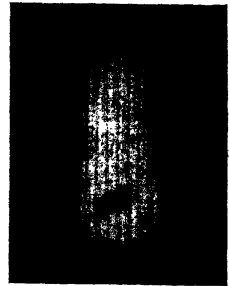


FIG. 15. — Photographic check when using vertical illuminator method. Taken with $\frac{1}{3}$ -inch o.i. objective.

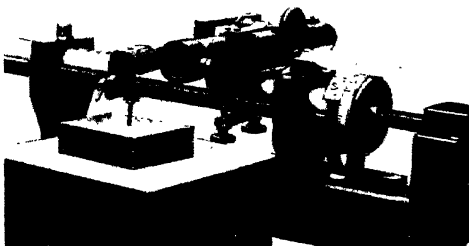


FIG. 5.—Improvised ruling engine.

given objective, for if d is the size of a grating space of the minified image when the grating is normal, and if θ is the angular turn of the grating when resolution ceases, then

$$d_{\theta} = d \cdot \cos \theta.*$$

This formula was used for the determination of the results obtained in the work, and for a relative comparison on these Abbe's well-known formula $d = \frac{.5 \lambda}{N.A.}$ was used.

THE APPARATUS.

Owing to the exacting nature of observations taken near the point at which resolution just ceases and to the fact that different observers express

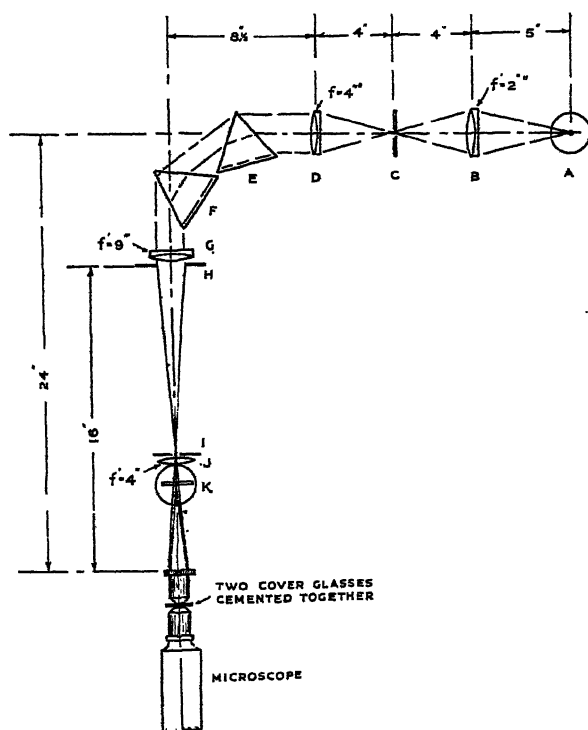


FIG.4—OPTICAL SYSTEM (1ST METHOD) DIAGRAMMATIC.

varied opinions as to the limit of resolution, it was decided to record all results photographically and thus eliminate errors due to the human eye; hence the apparatus consisted essentially of a complete photomicrographic

* Further remarks on the validity of this formula considered on the diffraction theory are given at the end of the paper.

bench together with certain auxiliary equipment for mounting the grating and carrying the special form of illuminating system. The entire bench was fitted with a shock-absorbing device, in order to reduce vibration as much as possible.

The complete apparatus is shown in fig. 2. The fittings on the right constitute a monochromator, whilst in the centre and on the left will be seen the grating mounted on its table, the microscope and a portion of the camera. A closer view of the grating mounting together with the auxiliary objective held by a suitable adaptor in the substage condenser ring is shown in fig. 3.

The illuminating system was so arranged to provide a means of fulfilling two conditions—firstly, that light of any wave-length could be used at will ; and, secondly, that the back lens of the auxiliary objective should be wholly filled with this light. The apparatus employed for the purpose of doing this will be best understood from fig. 4. The illuminated ball of a Pointo-lite lamp (100 c.p.) A was focussed on the slit C by means of a condenser B. A parallel beam emerging from the collimator lens D passed through the two prisms E and F, and the spectrum thus produced was brought to a focus by the lens G in the plane of the iris diaphragm I. The diameter of this aperture was 3 mm. and, being small in comparison with the length of the spectrum, it only allowed light to pass which was reasonably monochromatic. By swinging the collimator portion of the monochromator, any desired part of the spectrum could be brought over this hole, and the grating K thus illuminated with a particular wave-length. The purpose of the lens J was to form an image of a second diaphragm H ($\frac{1}{2}$ in. in diameter) in the plane of the back lens of the objective, the size of H being varied until the back lens was wholly filled with light.

The divided circle on which the grating stood was 3 in. in diameter (reading to 2 mins. of arc), and was suitably fitted on to an optical bench.

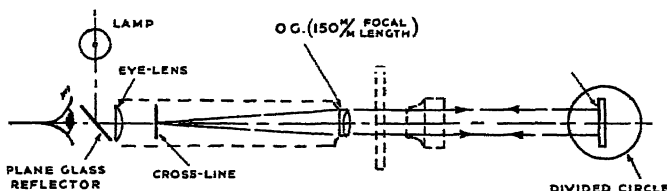
The gratings themselves consisted in one set of experiments, of a piece of process screen (ten lines per millimetre), and in other experiments of rulings 20 lines and 50 lines per millimetre made on a piece of silvered glass. Such gratings as the latter were made successfully by converting a measuring microscope into an improvised ruling engine. This device with the cutting tool attachment is shown in fig. 5.

EXPERIMENTAL METHOD OF DETERMINING THE RESOLVING POWER OF AN OBJECTIVE.

It is not considered necessary to go into the experimental work in great detail as microscopists are fully aware of the usual precautions that are required in order to obtain the best their optical system will produce, but the procedure other than this is given in main outline :—

1. The correct tube-length of the objective to be tested and the auxiliary O.G. are determined.

2. The grating must be mounted centrally over the axis of rotation of the circle and adjusted to be at right angles to the optical axis of the microscope (proper). This last adjustment is done by temporarily converting the microscope into an auto-collimating telescope, the method being depicted in fig. 6, which is self-explanatory.
3. The monochromator is then placed in position and the grating illuminated.

FIG. 6—SETTING GRATING NORMAL TO OPTICAL AXIS—1ST METHOD.

4. With the object-forming lens in position in the substage, a special slide must be mounted on the stage. This slide consists of two cover glasses (of correct thicknesses to suit each objective) balsamed together and mounted in a recess on a brass 3 in. by 1 in. slide. One of the interior surfaces of the cover glasses is silvered and has a line ruled on it (see fig. 7). The purpose of this line is threefold: it

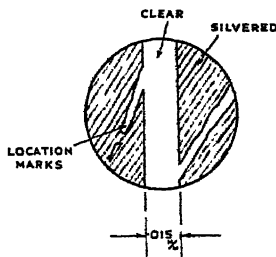


FIG. 7.

provides an object on which to focus the microscope and thus ensure that the image produced by the auxiliary objective was formed *between* the two cover glasses. Secondly, it gives a means of providing a direct check of the separation interval of the lines of the "object," for the edges of the line on the silver film and the image of the gratings lines are focussed simultaneously on the photographic plate, and therefore the number of lines corresponding to a known width of the line on the silver can be counted up and the object interval obtained. Thirdly, by measurement of the width of the photographic image of the line on the silver film a permanent record

of the magnification employed is supplied. The use of such a slide with different objectives is shown in fig. 8 (*a, b, c*).

5. With the above slide in position and the line on the silvered surface in focus with the microscope proper, the image of the grating lines is brought into focus in the same plane by adjustment of the condenser mount in which the auxiliary objective is situated.

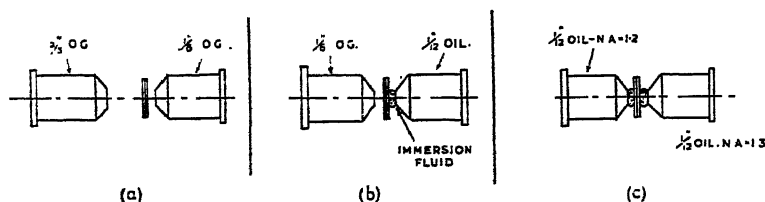


FIG. 8
METHODS OF EMPLOYING THE COVER-GLASSES WHEN TESTING DIFFERENT OBJECTIVES

6. With the grating normal to the optical axis the size of the line interval of the imaged grating has then to be determined. This may be done by the use of a micrometer eyepiece in the microscope proper of which the primary magnification has been previously obtained. Figs. 9 (*a* and *b*) show photomicrographs of the line on the silver film and the imaged grating lines simultaneously in focus with the grating normal to the optical axis. In this position the lines would be ready for measurement.
7. Whilst observing through the microscope, the grating is then rotated until the position at which resolution ceases is nearly reached. The camera is then brought up behind the projection eyepiece and a series of photographs taken on one plate or on a film, the angular rotation of the grating being increased between each successive exposure.

It will be found that successive rotations of half a degree are sufficiently small, such an angle only affecting the final resolution value by less than 1 p.c. up to 70° swing of the grating.

After five or ten exposures have been made in this way and the plate developed, examination of the latter will enable the reading of the circle to be obtained when resolution ceases, and hence the corresponding value to be calculated.

An illustrative example of the effects obtained by the method are shown in fig. 10 (*a* and *b*). In *A* the grating was tilted through a large angle for each exposure, namely, ten degrees; it will be seen how the lines become successively closer and finally disappear. Fig. 10 (*b*) shows the effect taken at close intervals, namely, at an increase of thirty minutes (30') angular turn of the grating, the usual case.

As a numerical example of the manner in which the result of a 'resolution test' on an objective is obtained, the following figures actually determined with $\frac{1}{8}$ -in. O.G. are given :—

$\frac{1}{8}$ -in. O.G. under test.

$$\text{N.A.} = \cdot 71. \quad \lambda = \cdot 51 \mu.$$

Size of line interval of imaged object when grating is normal to axis = $\cdot 00099$ mm.

Photographs taken at

64° 30'	66° 0'	67° 30'
65° 0'	66° 30'	68° 0'
65° 30'	67° 0'	68° 30'

From examination of plate, resolution ceased at 66° 30' + 0° 30' (zero correction) = 67° 0'.

$$\begin{aligned} \therefore d_{\theta} &= \cdot 00099 \times \cos 67^{\circ} \\ &= \cdot 00038(8) \text{ mm.} \end{aligned}$$

Photographic check on size of "object."

Number of lines on photograph immediately before that at which resolution ceased = 38.

Width of line cut in silver film = $\cdot 015$ mm.

$$\therefore d \text{ (by check)} = \frac{\cdot 015}{38} = \cdot 00039(4) \text{ mm.}$$

Theoretical Resolution (Abbe) = $\cdot 00035(9)$ mm.

FIRST SERIES OF EXPERIMENTS.

The method was first applied to the testing of a $\frac{1}{8}$ -in. objective, determining the resolution in each case for a variation in wave-length throughout the visible spectrum. The following table shows the results obtained :—

Wave-length.	Resolving Power as Determined by Method.	Theoretical Resolution (Abbe).
	mm.	mm.
$\cdot 67\mu$	$\cdot 00122$	$\cdot 00119$
$\cdot 62$	$\cdot 00112$	$\cdot 00110$
$\cdot 585$	$\cdot 00106$	$\cdot 00104$
$\cdot 55$	$\cdot 00100$	$\cdot 00098$
$\cdot 51$	$\cdot 00094$	$\cdot 00091$
$\cdot 48$	$\cdot 00088$	$\cdot 00086$
$\cdot 45$	$\cdot 00081$	$\cdot 00080$

These figures are plotted in fig. 11. It is interesting to note how they illustrate the increase in resolution with a decrease in wave-length of the luminant, and thus confirm previous general experience.

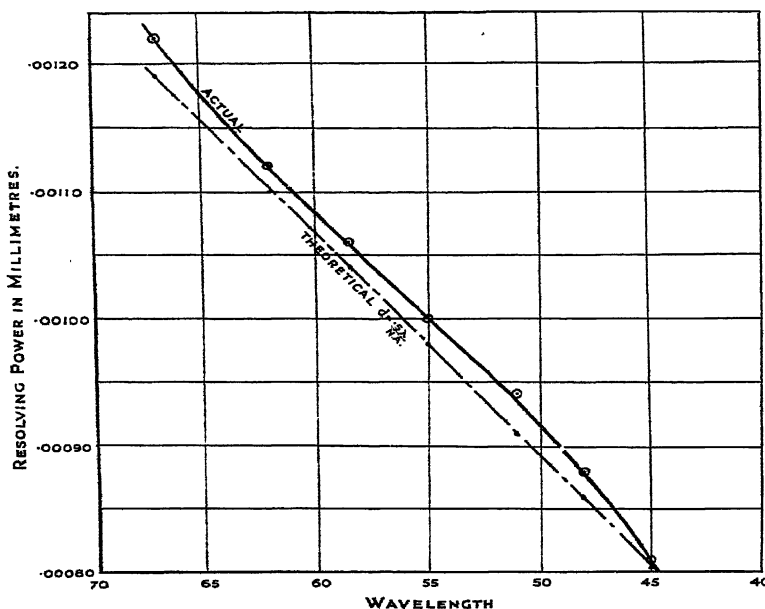
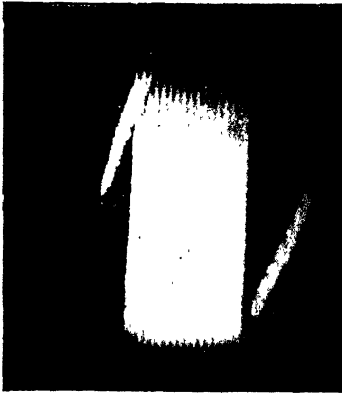


FIG. 11—THEORETICAL AND ACTUAL RESOLUTION OF $\frac{1}{8}$ IN. OBJECTIVE. N.A. = .28

Tests were also made on a $\frac{1}{8}$ -in. dry and a $\frac{1}{12}$ -in. oil-immersion objective, in this case using light of only one wave-length. The results are given below:—

Objective (Nominal).	N.A.	λ	Resolution Determined.	Theoretical Resolution (Abbe).
in.			mm.	mm.
$\frac{1}{8}$	.71	$.51\mu$	.00039	.00036
$\frac{1}{12}$ oil	1.2	$.51\mu$	.00024	.00021

Test using lower N.A. Objective as "Object-forming" Lens.—A little consideration will show that it is necessary to employ as the auxiliary objective one of either equal or preferably slightly higher numerical aperture than the



(a)

Taken with $\frac{1}{8}$ -inch objective.



(b)

Taken with $\frac{1}{8}$ -inch o.i. objective.

FIG. 9.—Line on silver film and imaged grating lines simultaneously in focus.
Grating normal to axis.

0°

10°

20°

30°

40°

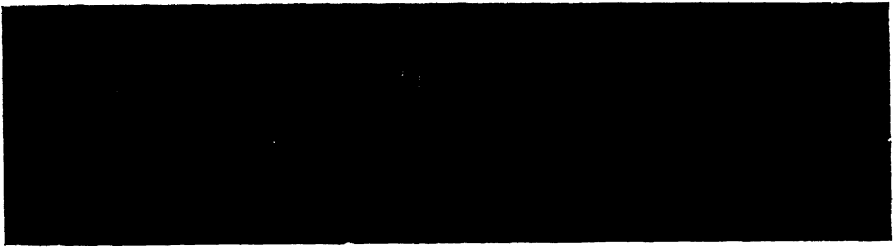


FIG. 10a.—Illustrative photomicrograph showing appearance when grating is rotated.
 $\lambda = .51 \mu$. Exposure = 1 minute.

65°

65° 30'

66°

66° 30'

67°

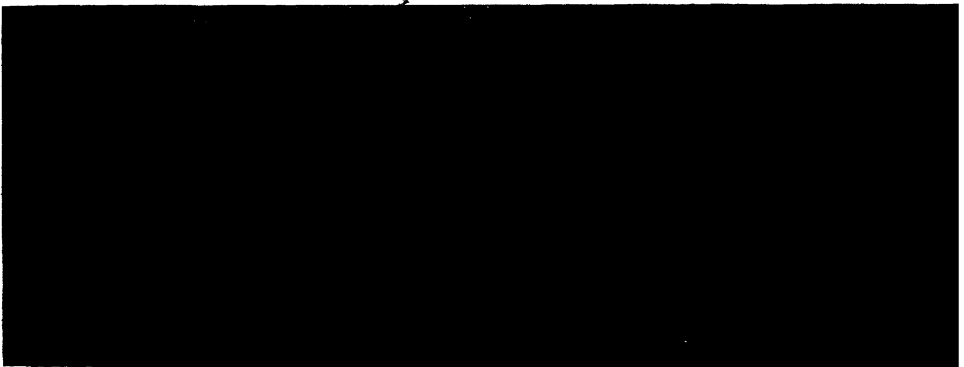


FIG. 10b.—Successive exposures with an angular increase of 30 minutes with grating. Taken with $\frac{1}{8}$ -inch objective. $\lambda = .67 \mu$.

lens under test. Nevertheless, it was thought to be of interest to verify this empirically, and the following figures were obtained :—

—	Objective (Nominal).	λ	N.A.	Possible Resolution (Abbe).
	in.			mm.
In Microscope (Proper) .	$\frac{1}{8}$	$\cdot 53\mu$	$\cdot 74$	$\cdot 00086$
In Condenser Mount .	$\frac{1}{8}$	$\cdot 53\mu$	$\cdot 53$	$\cdot 00050$

Actual resolution obtained = $\cdot 00054$ mm.

—	Objective (Nominal).	λ	N.A.	Possible Resolution (Abbe).
	in.			mm.
In Microscope (Proper) .	$\frac{1}{8}$	$\cdot 53\mu$	$\cdot 74$	$\cdot 00086$
In Condenser Mount .	$\frac{3}{8}$	$\cdot 53\mu$	$\cdot 24$	$\cdot 000108$

Actual resolution obtained = $\cdot 000119$ mm.

SECOND SERIES OF EXPERIMENTS.

The second set of experiments consisted of an attempt to adapt the method for use with a vertical illuminator, thus dispensing with the auxiliary objective. In this case the lens itself produces the minified "object," which it also observes, the light passing twice through the objective.

The apparatus was arranged as in fig. 12, the grating K being situated at the same distance from the objective as the final image produced by the latter. A silvered cover glass (of correct thickness) attached to a 3-in. by 1-in. slide, and mounted on the stage, served as the means of back-reflecting the image to be finally received on the photographic plate. The grating was illuminated by light from the monochromator and, as before, was rotated on its table in order to vary the line interval of the "object."

Among the experimental differences in this method, as compared with the former, is the selecting of a really good reflecting plate for the vertical illuminator; the usual microscope cover glass employed for this purpose was discarded owing to its poor optical surfaces. A collodion film stretched on a framework was tried, as its thinness is such that one single reflected image is obtained instead of the usual doubling that occurs. The writer was unsuccessful in producing any of these films, the surfaces of which were of sufficiently good optical quality for the exacting purpose to which they were to be put; but when a better method of mounting the film has been developed, it is hoped that it will yet be possible to use one, as it has been

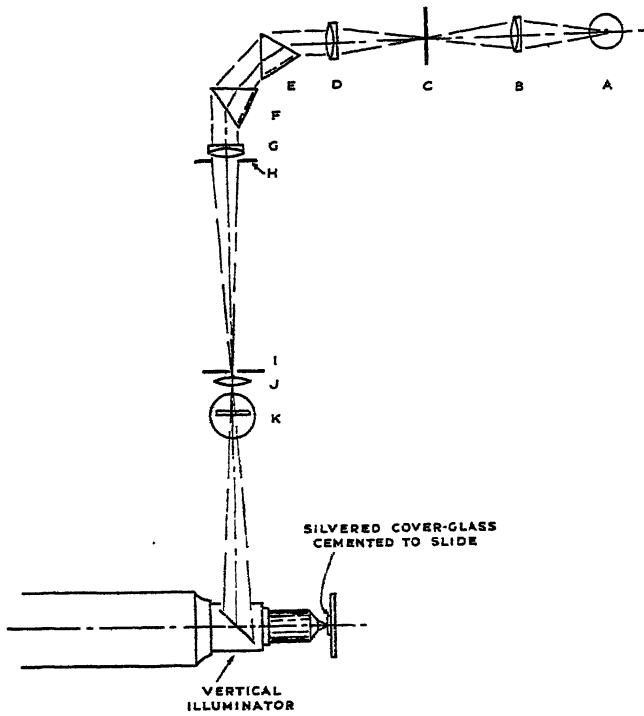


FIG.12-OPTICAL SYSTEM (2ND METHOD) DIAGRAMMATIC.

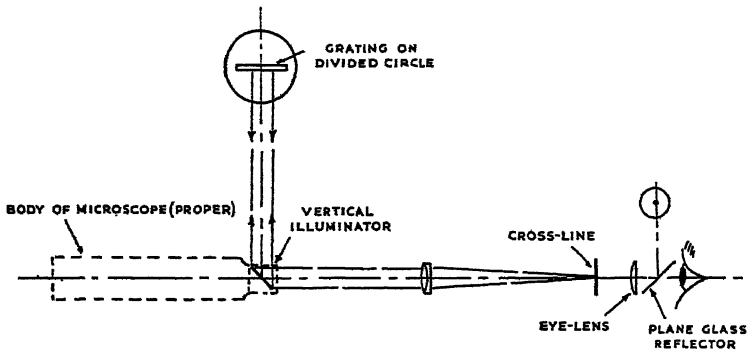


FIG.13 SETTING GRATING NORMAL TO OPTICAL AXIS-2ND METHOD

found that methylated collodion (in such a thickness) will transmit ultra-violet radiation in the region of $\cdot 275\mu$ quite satisfactorily.

Eventually a thin quartz plate was obtained with optically worked surfaces, and was so mounted that these surfaces were not distorted, and this was used in the experiments.

A variation of the method for setting the grating perpendicular to the optical axis had to be employed. This will be made clear from fig. 13.

Instead of using the ruled line on the silver surface for limiting the field and for the application of the photographic check on the size of the "object,"

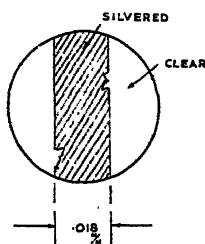


FIG. 14

a narrow strip of silver was left on the underside of the cover glass and the remainder being cleared away, see fig. 14. A photomicrograph illustrating this is shown in fig. 15.

Tests on the Three Objectives (Vertical Illuminator Method).—The routine for determining the resolution value of an objective by this method closely resembles that of the first, and therefore it is not necessary to repeat it. The following are the results obtained on the same three lenses :—

VERTICAL ILLUMINATOR METHOD.

Objective (Nominal).	N.A.	λ	Resolution Determined.	Theoretical Resolution (Abbe).
in.			mm.	mm.
$\frac{3}{4}$	$\cdot 28$	$\cdot 51\mu$	$\cdot 00099$	$\cdot 00091$
$\frac{1}{2}$	$\cdot 71$	$\cdot 51$	$\cdot 00042$	$\cdot 00036$
$\frac{1}{3}$ oil	$1\cdot 2$	$\cdot 51$	$\cdot 00026$	$\cdot 00021$

Consideration of Method on Diffraction Theory.—An interesting verification of the validity of the method may be obtained by investigating the theory along the following lines :—

In fig. 16 let O be the objective under test, A the auxiliary lens, and G the grating.

The numerical aperture of $O = N' \cdot \sin u_2 \equiv N' \cdot \sin u'_1$. But $N \cdot h \cdot \sin u_1 = N' h' \cdot \sin u'_1$ (Lagrange).

$$\therefore N' \sin u'_1 = N \cdot \sin u_1 \times \frac{h}{h'} \quad \left\{ \begin{array}{l} h = \text{line interval of grating.} \\ h' = \text{image of this.} \end{array} \right.$$

Consequently, if known values (obtained by actual measurement) of $u'_1 (\equiv u_2)$, h and h' are put into this formula, a value for $\sin u_1$ can be obtained.

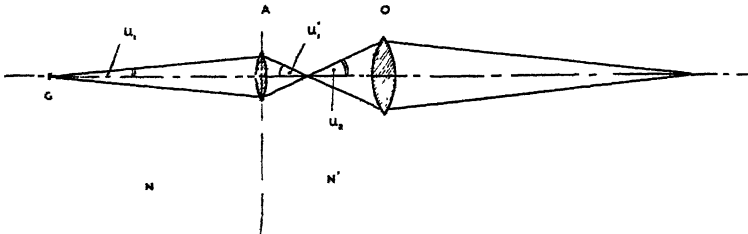


FIG.16. ILLUSTRATING EFFECTIVE N.A. OF OBJECTIVE UNDER TEST

Also a value of $\sin u_1$ can be determined from the recorded angular rotation of the grating when resolution just ceased. According to the Abbe theory of microscopic resolution we should have $2u_1$ equal to the angle

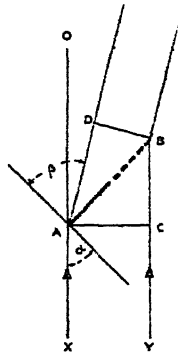


FIG.17. SHOWING DIRECTION OF FIRST DIFFRACTED BEAM WHEN GRATING IS INCLINED TO DIRECT BEAM.

between the direct beam and the first diffracted beam. A comparison between the two results thus obtained would give an idea as to the manner in which the rotation of the grating gave a representation or otherwise of the N.A. of the lens under test.

In order to obtain the angle between the direct and first diffracted beams from the angular position of the grating, reference must be made to fig. 17. The case is represented when the grating AB has been rotated through an angle α to the position at which resolution ceases for the lens under test.

It is required to determine

$$\angle OAD = \beta - \alpha.$$

If AB (called here e) represents one grating interval, for the first diffracted beam AD-BC must equal one wave-length (λ).

Then
$$\lambda = e (\sin \beta - \sin \alpha)$$

Hence
$$\sin \beta = \frac{\lambda}{e} + \sin \alpha,$$

Substituting known values of λ , e , and α in this formula, a value for β can be obtained, from which $(\beta - \alpha)$ gives the angle $2u_1$. A comparison of the two sets of values obtained in this way is given for each of the objectives which were tested:—

Objective.	$2 \cdot N. \sin u_1$ determined from known N.A. and magnification $\frac{h'}{h}$.	$2 \cdot N. \sin u_1$ determined from known rotation of grating and angular displacement of first diffracted beam
in.		
$\frac{3}{8}$	·0112	·0111
$\frac{1}{2}$	·0140	·0134
$\frac{1}{1\frac{1}{2}}$ oil	·0254	·0233

The nature of these figures is sufficient to indicate that the use of the simple formula involving the cosine of the angular rotation of the grating, may be relied upon to give a measure of the resolving power of an objective, and as a relative means therefore of testing the performance of such lenses.

CONCLUSIONS.

A summary of the results obtained in the work indicate that it is possible to obtain a reliable numerical value for the resolving power of a microscope objective when used in the visible region of the spectrum.

The first method has the disadvantage of having to use an auxiliary objective of N.A. slightly greater than the one under test, which means that the highest power objective which it is possible to make could not be tested to the limit. Nevertheless, the method might be useful for many purposes. The results obtained by the method, as compared with the theoretical value given by Abbe, agree extraordinarily well—in fact, so well that, after allowance has been made for the inevitable imperfections still existing even in the best lens system obtainable, one is led to think that it

is possible that Abbe's formula represents a high limit for the theoretical resolution of a microscope objective, a fact which has been previously suggested by this department.

The vertical illuminator method has the advantage of using one objective alone for the test, and therefore in spite of the fact that the light has to pass twice through the lens, with a consequent doubling of any existing aberrations, the method could be employed for testing the relative merits of lenses of the highest N.A. in the limit.

It will be noticed that the determined resolution for the three objectives when tested by the vertical illuminator method is slightly higher in each case; this may be possibly due to the definition of the final image being impaired by the introduction of the reflecting plate in the path of the convergent beam emerging from the lens.

Both methods have the advantage of using an "object" which can be varied in size whilst under observation. Moreover, the object proper takes the form of a grating of relatively large intervals, namely, ten or twenty lines to the millimetre, which is an easy article to procure or make; in fact, one of the gratings used in the work was a standard piece of "process screen" of 250 lines per inch. For the higher power lenses, however, it is better to use rather a more finely ruled grating (say, 50 or 100 lines per millimetre), so that the angular position of the latter when resolution ceases is not far from the normal position.

Application of the Methods for Use with Ultra-Violet Illumination.—The original intention was to find a method which could be applied in the ultra-violet region of the spectrum for obtaining the resolving power of a quartz (or other ultra-violet transmitting substance) objective. Some initial experiments have been started in this direction, employing a duplicate of the system shown in fig. 4 in quartz. The grating was made by ruling lines on the silvered surface of a quartz plate by means of the improvised ruling engine (fig. 5), silver having proved in this case to be opaque to ultra-violet radiation of wave-length $275\ \mu\mu$. As the work has only recently been commenced, it is not possible to say more at the moment, except that there is every reason for believing that either or both of the methods will afford a means of obtaining a direct numerical test on the possible resolution of objectives used in ultra-violet radiation.

The paper would not be complete without an expression of thanks to Dr. L. C. Martin and Prof. A. E. Conrady for their helpful suggestions made during the progress of the work.

REFERENCES.

- HARTING, P. (1866).—"Das Mikroskop." Braunschweig.
LISTER, J. J. (1837).—"The Unpublished Papers of J. J. Lister" (communicated by Prof. A. E. Conrady), *J. Roy. Micr. Soc.*, 1913, 33, 27-85.

VIII.—METHOD OF ILLUMINATING GREENOUGH BINOCULAR MICROSCOPE BY TRANSMITTED LIGHT WITH PAIRED MIRRORS.

By S. C. AKEHURST, F.R.M.S.

(*Read May 16, 1928.*)

WITH ONE PLATE.

THE Greenough binocular microscope consists of two microscopes in juxtaposition. An ideal method of illumination, when employing transmitted light, would be a combination including a pair each of lamps, mirrors, and condensers. This scheme would be both cumbersome and expensive.

A simpler method is to use frosted glass under the stage, producing diffused light, but, whilst the desired result would be obtained of filling both objectives with light, the resulting image would be unsatisfactory, and is, therefore, a form of illumination to be avoided.

An alternative method is to employ a pair of D-shaped mirrors attached to the tailpiece and mounted in such a manner as to permit universal movement.

One lamp only would be required, with stand condenser fitted with an iris diaphragm.

Fig. 2 shows the arrangement of three gimbals used in mounting the mirrors. The main gimbal is attached to the tailpiece of the microscope. This can be tilted in one direction only. To this is fitted two smaller gimbals, each carrying a D-shaped mirror in a metal mount. Both mirrors can be moved in two directions.

This combination permits the mirrors to be placed in the desired position to receive a beam of light from the lamp and reflect same at an angle—through the substage condenser—parallel to the optic axis of each of the paired objectives.

With the mirrors set, no further adjustment of the lighting is necessary when change of objectives is desired.

Care should be taken in selecting a suitable substage condenser, which should have a low numerical aperture, be well corrected, and have a large flat field. An iris diaphragm fitted to the substage condenser is unnecessary; any attempt to use it in this position causes partial and irregular illumination of the objectives.

Light control must be arranged by the iris diaphragm on the stand condenser.

When working, it is important to see that the lamp, stand condenser, and mirrors are in perfect alignment.

In mounting the mirrors, the two straight sides (see fig. 1) should be as close together as is consistent with freedom of movement.

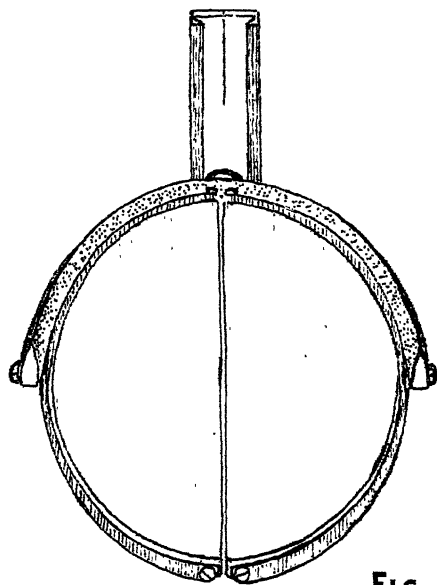


FIG. 1

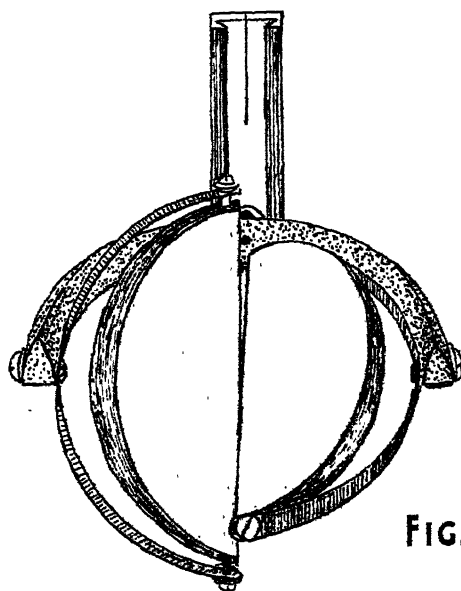


FIG. 2.

S.C.A

A REVIEW.

THE MICROSCOPY OF RADULÆ.

By E. W. BOWELL, M.A., M.R.C.S., L.R.C.P., F.R.M.S.

WITH THREE PLATES.

I.

THE radulæ of snails are subjects of great interest and complexity. As microscopic objects they have not yet received the attention they deserve. Varying in length from several inches to a fraction of a millimetre, they provide material for the exercise of the special microscopic art of deciphering small structure by reference to allied forms which are less small, proceeding from the more to the less easily intelligible. In some other fields of research the opposite course has been taken, with bad results. Mr. Conrad Beck pointed out to the Society, a little time back, that the more logical method of studying the structure of diatom frustules was to begin with the simpler ones which have structure capable of being explored with a comparatively low power. When these are understood, we are in a position to proceed to the more minute forms. This certainly holds good in the case of radulæ, and it conveniently corresponds to the fact that increasing skill is required in the manipulations necessary for making preparations of the smaller forms. Very few workers have as yet studied the radula in detail except in the case of the very large forms ; this has been due to the optical shortcomings of the medium generally employed, to the failure of malacologists to use the fine preparation microscopes which are needed for the work, and to the lingering belief that a drawing can do justice to the structures in question. The arts of microscopy exist largely to show naturalists how such difficulties can be overcome, and we are in a position to-day to investigate radulæ with the help of apparatus and theory not available to any of our predecessors. A short account of the history of the study may assist in giving perspective to the subject.

II.

The inspired curiosity of the father of sciences led him to the discovery that snails have little, sharp teeth (1). When the world again awoke to the value of curiosity about the facts of Nature, we find Dr. Martin Lister

investigating the anatomy of snails and finding these same teeth (2). However, there is no doubt that the teeth referred to in these notices are the serrations on the upper jaw (maxilla, Kiefer, machoire) which occur in large species of snails. Even Leeuwenhoek and Swammerdam seem to have missed the radular teeth; but they were certainly observed by Adanson, a naturalist who was ahead of his time in other respects also (3). The question of his status as a nomenclator must appear a mighty small issue when we find that he made anatomical observations on the animals he described which enable us to recognise them far more surely than do the terse Linnæan definitions. He found that the radular teeth were in regular and similar rows; but it took a long time for the obvious physiological deduction to be made from this fact. He also counted the teeth in these rows, observed that the numbers differed in different species, and was thus a pioneer of statistical biology. As the microscopes then existing were quite capable of showing many of the details of structure in individual teeth, he might have pursued the matter further; but it was something to regard them as units. William Thomson, a century later, wrote a paper in which the numbers of the teeth are still the chief consideration (4); the details which he complains he could not make out are quite readily seen with the help of an Andrew Ross microscope built five years before the date of his paper. Many more recent examples might be given to show how radulographers have neglected to avail themselves of the best help that the microscopy of their time could afford, and in so doing have discounted the value of their work. These are here passed over, as the object of this paper is to stimulate investigation, not to raise controversy. But it may be pointed out that the special duty of a Microscopical Society is to ensure that those who are engaged in researches involving microscopy shall be kept informed of important advances in microscopical art. In the period intervening between Adanson and Thomson, roughly while the modern microscope was yet in embryo, a beginning was made in the description of radulæ of mollusca in general, but more particularly in the case of marine forms, which are sometimes large, and usually provided with relatively few teeth, of curious and characteristic form: Docoglossa, Tænioglossa, Stenoglossa. The mention of these group-names brings us to Lovén, the great naturalist who invented classification by "tongues," because when engaged on a faunistic work he found the earlier classification by shells only to be inefficient and chaotic in its results. In a single paper (5) he figured the radulæ of ninety-two species, proposed the new group-names, and brought about the reform of classification. Eleven of the figures are reproduced in the better-known paper of J. E. Gray (6). Many of them are copied, this time with due acknowledgment, in S. P. Woodward's *Manual of the Mollusca*, and a considerable number by Woodward himself were added. (The originals of these, by the courtesy of Mr. B. B. Woodward, were shown to the R.M.S. at our meeting on May 21st, 1924.) Thus by the beginning of the second half of the nineteenth century there was a considerable body of information available. In 1893

Theile completed Troschel's great work begun in 1856 (7), which dealt with the subject on the same lines, and is very finely illustrated. The subject was not, however, worked out; for even Troschel has nothing to say about the Pulmonata, and in English, and to landlubbers, Pulmonata are "snails." There is no general treatise on the radulæ of Pulmonates. Moquin-Tandon (like Aristotle) contents himself with describing the "machoire." Several English manuals have copied the figures of Lovén and the numbers of Thomson. Steenberg has given an excellent preliminary account in a local fauna. J. W. Taylor, in his Monograph (unfinished), gives very full descriptions and figures; these are all original, and the source of the information is given with meticulous care. The difficulty of obtaining this information is aggravated as the smaller species are reached, and in proportion as it is realised that the radulæ of embryonic snails ought also to be included. For the appearance of the radula is in most cases as early as that of the shellrudiment.

To enumerate all the papers in which the radula of a species or group of species has been described incidentally, as part of a general description, would be a long and not very profitable task, owing to the great inequality of the work. In general it may be said that the descriptions are meagre and the figures conventional.

America has produced a long series of malacologists who in the amount of their published work have fairly put the Old World to shame. But they would probably be the first to say that there is plenty more to be done.

The museum phase of natural history has had its importance overrated in the past, but a man who succeeds single-handed in bringing together an enormous collection of specimens, as the late Dr. H. M. Gwatkin did, has made science his debtor. Unkind fate made him also a polymath, but his collection in the British Museum remains to show to what good purpose a truly learned man may spend his leisure.

Rücker described the mode of development of the radular teeth in *Helix pomatia* in 1883 (8). His paper was soon followed by the much more satisfactory account (9) of Rössler (1885), who pointed out that each longitudinal row consists of teeth each of which has been formed by the same group of cells, and that each tooth (uncus) thus formed is subsequently coated with enamel (*Glasur*) secreted by the upper layer of cylindrical cells. Rössler's account was derived from examination of a large number of species of different groups, and he was probably the first to use modern methods of sectioning. There is still a great deal of uncertainty as to the details of the process of forming and forwarding the teeth. It is difficult to study such highly unsymmetrical structures by the section method, and both the enamel and the chitin must be softened before a complete longitudinal section can be made. In practice the softening of the enamel means its removal, and this causes a collapse of the tissues.

III.

There are three modern methods of investigation which may be applied with great advantage to the study of radulæ—staining, photography, and stereophotography. Not one of these has yet had a fair trial, though it is hoped that the illustrations accompanying this paper will prove that the first two are successfully so applied. The present section will, therefore, deal with the methods of mounting radulæ as microscopic objects.

Radulæ are usually cleaned from the attached epithelia of the sac, the elastic tongue membrane, and the muscles of the odontophore, by boiling the odontophore entire in caustic alkali, when the tissues mentioned are dissolved, leaving the radula itself uninjured. The membrane on which the teeth are carried consists of crossing fibres of chitinous material, in structure very much resembling paper, and, like paper, possessing a remarkable strength when the comparative looseness of its fibres and its thinness are considered. This membrane is thickest where it underlies the thicker teeth; thus in the common snail there is a thickening across the whole central part, while in such a species as *Hyalinia lucida* (fig. 2) there are two thickenings, one on each side of the middle line, underlying the lateral teeth, which are exaggerated in size. As a rule, the membrane is strong enough to carry the teeth safely through the processes of mounting, but those which have lateral thickenings are liable to split down the middle. The method of boiling out the radula in caustic alkali was probably introduced by Troschel in 1836. After the cleaning is performed, there still remain thin coats over the top and underneath the radula, representing the remains of the epithelial layers which have been destroyed by the alkali, or perhaps the less soluble basement membranes of these epithelia themselves. That they are sometimes stripped off with ease suggests that the latter explanation may be the more correct. The upper membrane does not extend over the front third of the radula; the epithelium which it represents is that which has secreted the enamel covering of the teeth.

Goldfuss stated that caustic potash was better than caustic soda, for the curious reason that caustic potash makes soft soaps and caustic soda hard ones. They are, in fact, equally useful for the purpose of destruction, and as fats or oils are not present in the tissues, it is not a case of soap-making. Most descriptions of this and other processes in which caustic alkalis are used for destroying tissues by violent hydration advise that saturated or strong solutions should be taken; this is quite a mistake, for one or two per cent. solutions are much more effective and less unpleasant to handle. It is the water that does the work, but water plus heat would fix the epithelium, which is not desired. It is well known that the success of ordinary fixatives depends (amongst other things) on the reaction of the object fixed and of the fixative fluid; this is why success is not obtained by dropping absolutely fresh and living tissues into the fixative, as happens, for example, in that disappointing method of making sections of blood corpuscles by allowing

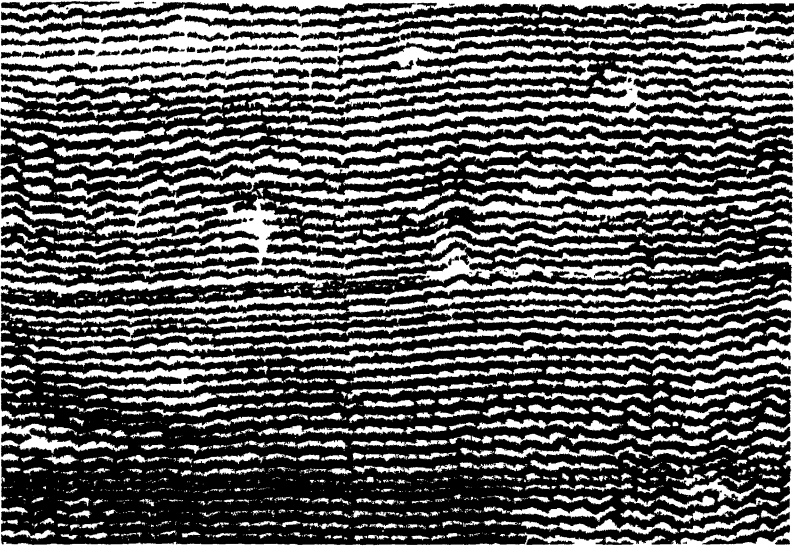


FIG. 1.

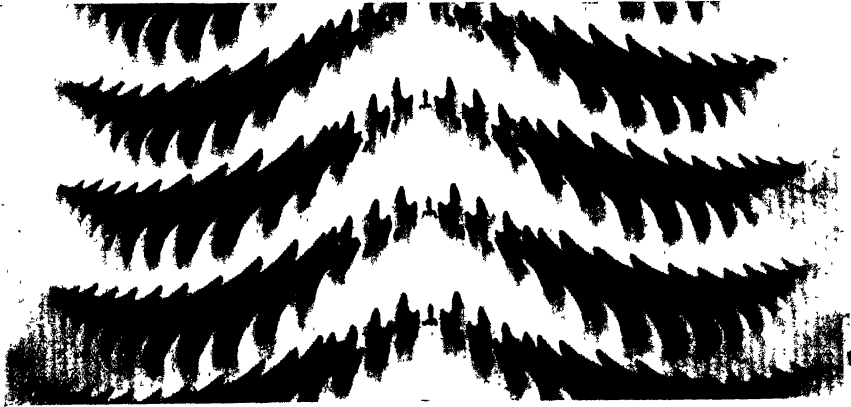


FIG. 2.

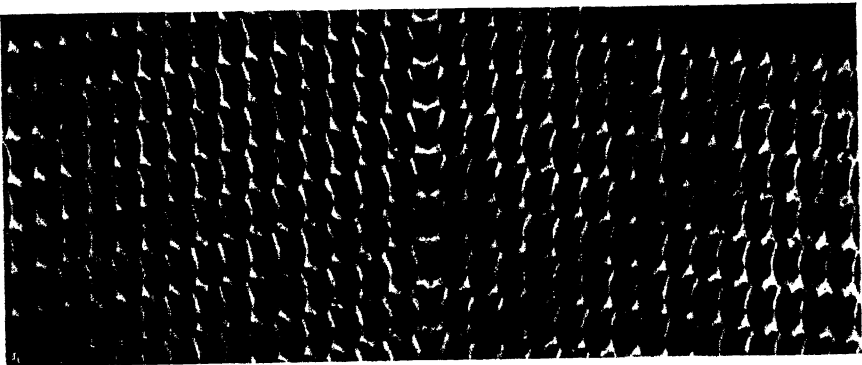


FIG. 3.

blood to drop directly into a fixing solution. Although it does not make much difference in the long run, it is a fact of experience that radulæ are much more quickly cleaned by killing the animal first than by cutting the heads off and dropping them straight into the boiling caustic solution. Imperfect cleaning is one of the great obstacles to the preparation of small radulæ, so that this point is sometimes of practical importance. The plan sometimes advised, by which the radula of a minute species is roughly isolated on the slide and then covered with a drop of caustic potash and boiled over the lamp-flame, is undesirable for the reason that very strong caustic potash is less destructive in its action, and produces incomplete cleaning; the concentration, of course, goes up rapidly when a drop of the reagent is boiled. The test-tube (probably borrowed from the usages of clinical medicine) is by no means a satisfactory vessel to do the boiling in. It is much better to use a small nickel basin on a suitable support. Platinum would be the best material, as nickel is damaged to a slight extent. Recently I have been using a small basin of resistance glass, which has the advantage of allowing lens examination of its contents (after cooling) with transmitted light. A small radula can be identified (as a radula) in such a basin by observing the interference colour produced by its fine and regular structure, varying with the actual size of that structure, just as diatoms appear coloured when viewed with objectives of insufficient aperture to ensure resolution. If the simple microscope used for this purpose is sufficiently large and has an adjustable mirror and arrangements for controlling the illumination, it is safe and easy to clean the smallest species in a basin of resistance glass.

The boiling is not an essential part of the process, but enables the destruction of the cellular tissues to be carried out more quickly, and is an easy way of keeping the object in motion during the operation. Fresh odontophores, which have not been dried or placed in any preserving fluid, will be cleaned in one per cent. caustic soda in two or three days without further attention. If the specimens have been kept in formalin, and penetration has been achieved by not using the formalin too strong, it is better to treat them first with peroxide of hydrogen, as otherwise the caustic alkali acts very slowly. When the smell of formic acid is no longer detected, the fluid is poured away and replaced by a dose of fresh dilute caustic.

If the odontophores are extracted and wrapped up in filter paper, they may be dried and kept for years in a tin box with a little naphthalin until a suitable opportunity comes for extracting the radula. The filter paper can be marked with name or number and locality. This plan is of great advantage when capture of the animals must take place at a distance from the laboratory, especially if staining is contemplated; for in the dead animal, whether it is dried or placed in liquid preservative, tissue reactions go on which may quite spoil the staining. On the other hand, the simple operation of odontophorectomy followed by drying in filter paper gives us material to deal with which is in almost unaltered condition, decomposition of the large glandular organs being mainly responsible for the changes referred to. Nevertheless,

any dead and dried or spirit-preserved snail will produce a radula in some sort of condition, no matter how old the specimen is. Glycerin is to be avoided as a preserving medium, for it is (as histologists have pointed out) a decalcifying agent. Specimens that have been kept in it show destruction of the enamel. Thus a bottle of radulæ which had been kept in glycerin for about twenty years yielded no specimen in which the characteristic form of the middle (thickened) teeth of *H. pisana* could be detected, though the side teeth, which have very little enamel, were coloured readily with acid stains. The same befell some hundreds of specimens of *Limnæa* which I collected and placed in glycerin in Mesopotamia. The action of the glycerin was no doubt accelerated by the heat of the climate in the latter case. This may be one reason why radulæ mounted in glycerin jelly are sometimes (in the case of species showing fine structure) found at the end of some years to show too little contrast detail to enable photographs to be made without reducing the W.A. below that which is necessary to give the desired resolution of the finer details, thereby producing the well-known reversal of light and dark in the resulting photograph.

If no staining process is contemplated, the clearing with caustic may be omitted. There are even advantages in so doing. The fresh radula can be drawn out of the front end of the odontophore of a decapitated snail, the only special instruments required being a small knife to cut off the front of the sac with the maxilla, and two sharpened match ends to exert the necessary traction without tearing the radula. It will usually come out quite easily, and will lie flat on the slide. By this means an undistorted specimen of the *Physa* radula may be obtained. How further to proceed after this first successful step has yet to be devised; for though the specimen is well laid out, it requires cleaning from the masses of epithelial cells which lie upon it and are derived from the enamel-forming blanket. The usual fixatives are unsuccessful, for when they are applied, the radula at once begins to contract and assume the form which it shows when treated in the usual way with caustic. The most promising method is to wet it cautiously with a bichromate solution and allow it to dry, afterwards exposing it to sunlight, for fixation to the slide, before attempting to clear away the epithelium. In certain cases (*Planorbis* especially) in which the radula is long and has a great tendency to break in two at the middle—that is to say, where the completed and exposed rows of the radula begin—this method may be valuable.

Returning to the ordinary process, the difficulty of removing the alkali, when it has done its cleaning work, is rather considerable. If an acid is added in small doses by way of neutralising the soda, it may be found that the acid adheres to the structure more strongly than the alkali. The presence of either in a free state will make much difference to the staining, unless it happens to be an essential part of the staining method. Bordeaux red, for example, will only stain the chitin in the presence of free acid; free acid, however, precipitates eosin and its allies. It is curious that acid must be

absent if a good sharp stain of the enamel with a basic dye is required. This is why Ehrlich's hæmatoxylin will not do, though hæmatoxylin itself is a good, though usually too powerful, stain for the enamel. The failure of basic stains in the presence of acid may be accounted for by the fact that the acid continues to act upon the enamelled layers of structure after the stain has gone into them; the result, if this is continued long enough, is to leave a diffuse stain inside the substance of the tooth, while the actual outline is scarcely visible. The acid stain produced by Bordeaux red is not removed by washing either in water or in alcohol, so that if the specimen is sufficiently washed between the processes, a second staining with a basic dye is easily possible. However, we have to choose a basic dye for this purpose which will not combine with Bordeaux red in the tissue to form a compound soluble in alcohol, that will not also stain the chitin itself, and that will be permanent in Canada balsam. These provisos limit the choice considerably.

The question of staining is here only touched upon in regard to its dependence upon the condition of the radula after cleaning with caustic, but before proceeding to the actual mounting, it may be observed that there is another way of clearing the radula of its protoplasmic coverings, namely, by incubating it in a pepsin or trypsin solution, together with a proper proportion of hydrochloric acid or sodium carbonate, as the case may be. In the absence of the inorganic compounds the method does not act; when they are present in excess, it acts extremely badly; it acts well when they are cut down to a minimum, the measurements being made with very great care. The smell of the products of digestion is unpleasant, but the process needs only to be carried out on a small scale. The waistcoat pocket is a satisfactory incubator. If the pepsin method is chosen, and it is rather more effective, the process must be stopped at the right moment, or the enamel will be found to be eroded in numerous tiny holes.

It is desirable to watch all the proceedings of preparing the object under the microscope. No rules for time to be taken over the different stages can be of the least value, owing to the varying size of the structures, the uncertainty as to complete removal of alkali, and the changes which occur in solutions of reagents kept in glass bottles, no matter how carefully they may have been originally made up. A simple microscope with good corrected lenses is sufficient, except for the small species, at all events for the preliminary steps; but since it is inconvenient to use a 40-diameter lens for any length of time as a guide to small operations on the stage, a compound microscope with Porro erecting prisms is almost a necessity. All the older types of erecting microscope are open to some serious objection. As to resolving power, here, as always, the one most important matter, the Greenough binocular, is on a level with good Steinheil lenses or Rohr anastigmats. It is not of any use to enlarge the pictures that it gives by the use of unusually highly magnifying oculars, their goodness or badness having already been settled by the objective. It is a defect in this sort of microscope that it cannot satisfactorily be used with artificial light unless some special arrange-

ment is provided for an extended light source. The best plan, in my experience, is to use two additional mirrors, reflecting the light from opposite sides of the same flame upon the same mirror, the direct light from the flame to the centre of the mirror being blocked. Daylight is, however, better for all these proceedings. But small species, in my experience all that are below the size of a *Cochlicopa*, require a more liberal N.A. than the Greenough can give. For them a monocular image-erecting microscope with Porro prisms is required, and if the mirror is not very large and well lighted, a condenser will also be necessary. A condenser being a device to increase the numerical aperture of the beam of light that reaches the object, it will make visible small details such as radular teeth, which would otherwise be seen only obscurely or not at all. In arranging the minute radula on the slide we need to know for certain whether it is right side up; a very slight improvement in the illumination enables this to be done, so that the condenser is a time saver. Good hand-rests are another requirement for the perfect dissecting microscope. After some practice a $\frac{1}{2}$ -inch objective can be used with success, but the main use of the higher powers, which may range up to a sixth of low N.A., is to inspect the work during progress without removing it from the stage.

If the radula is properly laid out on the slide, with the teeth uppermost, it can be safely pressed down and blotted dry with a piece of cigarette paper. The under surface, if properly cleaned, is very smooth, and the radula will remain in position during the subsequent operations almost as well as a section does that has been attached by the water method. If, on the other hand, the smooth side is uppermost, it will adhere to the cigarette paper and come away. If the cigarette paper process is omitted, it is unlikely that the surface will be flat enough in the final preparation to allow a photograph to be taken. The method of mounting upside down on the cover-glass is therefore only suitable for the more easily managed forms.

The most ancient method of mounting was, no doubt, to dry the object on a lamina of talc and fit another lamina over it, then fixing the two laminæ into a recess in an ivory slide, holding it in place by means of a split brass ring. It is actually the case that some specimens are seen very well by this method. We can make use of it by mounting in air on a glass slide. This merely means that we leave off at the stage just described, being free to continue with the staining and balsaming and covering at any later date. There are some small species which, either on account of the abnormal distribution of the enamel or because of the unfavourable position of the basal-plates below the unci (preventing any clear view being seen of either when both are stained), cannot by any yet known process be seen well as stained specimens. On account of the numerical aperture required for resolution they are ineligible as glycerin jelly objects, because with such minute structures sufficient contrast cannot be obtained without cutting down the aperture by closing the condenser iris to an abnormal extent, and thus introducing a fresh set of optical disadvantages in addition to that naturally

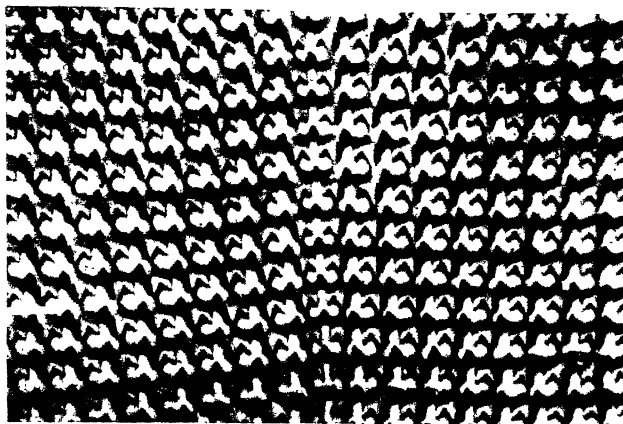


FIG. 4.

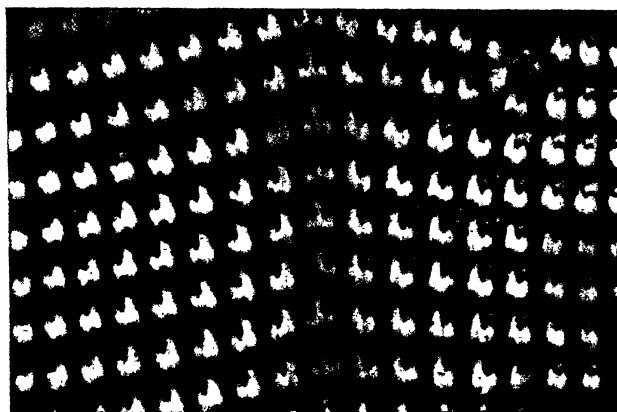


FIG. 5.

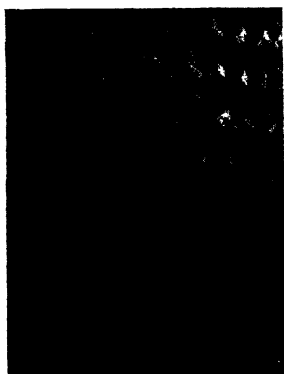


FIG. 6.

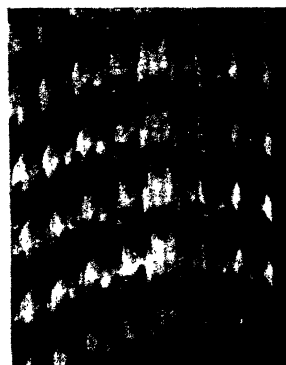


FIG. 7.

inherent in the medium. In such specimens the use of high powers does not permit increase of resolution, because the objective cannot function normally. These radulæ can, however, easily be seen when mounted in air. Actual comparison shows that the most convenient and practical way of arranging the apparatus is to use an objective corrected for use without a cover-glass, such as those used in metallurgy. Transmitted light, however, is used instead of incident. Figs. 4 and 5 show two *Vitrina* radulæ photographed in this way; they belong to two species which cannot with certainty be separated by examination of the shells. Some additional care is necessary in keeping such specimens, but I have some which have remained uninjured for several years; they could easily be remounted in the same way if they became dirty. In the case of species having large teeth this method allows us to see the actual layers of enamel on the unci, both in optical section and also well displayed in the partially broken teeth which always occur in the front part of the radula. The general effect is less perfect than that given by balsam preparations, because depth is of importance in these objects, and when they are mounted in air the least possible definition in depth is obtained.

Lovén does not state how he mounted his radulæ. They may have been simply in water. Troschel used glycerin, at least in his later work. Glycerin was first used about 1850. With its disadvantages I have already dealt. It is quite possible to preserve a radula in 2 p.c. phenol in water if a greater contrast of refractive index is required than glycerin jelly allows. The specimens keep remarkably well. Ringing is not easy. A rubber cement is used. Bending of the cover-glass over the object is frequently observed in glycerin jelly mounts, but it has not occurred in these liquid preparations. But, on the whole, if one desires to examine the specimen in water, it is easier to keep it in a dry state and add the water and a cover-glass when required.

Goadby's fluid was used by some of the early microscope slide makers who produced specimens for sale, and their preparations have in many cases survived for half a century or more with little change except that the radula has turned brown, betraying the presence of iron, which is a natural constituent (probably of the chitin, not of the enamel). These radulæ are often very thick (*Haliotis* was a favourite), and the glass is supported on strips cut from thin slides. The cover is also of stout glass, attached by a liberal application of black varnish. These preparations can often be remounted with success; a few species only are found, being the ones mentioned in old books on microscopy, and not requiring a high power for examination. Such details as are visible can usually be seen with a pocket lens. The existence of these clumsy preparations may have given microscopists the impression that snails' teeth were not very eligible as microscope objects.

The various methods of making safe a glycerin mount are known to most microscopists. It remains to describe in detail a glycerin jelly process

which may be applied to radulæ. So far as the mounting is concerned, the results are satisfactory enough if the precautions here detailed are taken; a collection of slides so mounted may last for years, and have a pleasingly uniform appearance. The clumsy method of painting melted resin or cement round the cover-glass is to be avoided. Round cover-glasses are used. Even if the mount is only intended to be temporary, it is less trouble to ring it in the proper way than to smear vaseline round its edges, unless, of course, it is only to be looked at for an hour or two. Use only good glass of uniform size. Place two stops permanently on your turntable, one being a corner-piece, so that you may be sure that all your slides have the same centre, and can be ringed and re-ringed in exactly the same place with ease and precision. Make a small diamond mark at one end of each slide, so that you may always know which is to be, say, its right-hand upper side. Then trace on each with a diamond a very light ring, slightly exceeding the diameter of the cover-glass which you intend to use. In the centre of this the radula is to be arranged; clean water only is used during the arranging. Sable brushes of the small sizes used by miniature painters are the best implements to use. It is well to press the specimen flat with cigarette paper, but to return some water to its surface afterwards with the point of one of the little brushes. A clean cover-glass is taken up with forceps, and on it is deposited a small lump of jelly, the size required being learned by experience. With the forceps this is held over a microburner for a moment to melt the jelly, and then placed, jelly upwards, on a small support on the table. The specimen on its slide upper side downwards is now brought down to meet the jelly, and the slide thus takes up the cover-glass, the traced ring showing where it is to go. If this is done neatly, and not too much jelly is taken, it is possible to avoid displacement of the specimen (which in the case of small ones usually means getting them rolled up). A very slight warming over the flame will enable any air-bubbles to be excluded, but while this is being done, it is advisable to hold the cover-glass in place with a pointed match applied to its centre (i.e. over the specimen). The cover-glass is pressed down lightly, and allowed to cool. In a few minutes it may be safely scrubbed with a clean toothbrush, under a stream of cold water, to remove all the jelly from the edges. It is wiped dry with an ordinary clean handkerchief. There might still be a little glycerin on the slide or the cover, so this is now wetted with a drop of ethyl alcohol, which is shortly afterwards wiped off with a clean rag, leaving the surface which is to take the cement quite clean and dry. It is well then to ring it at once; the stops on the turntable and the diamond mark will show exactly where the slide is to go. The cement to be used should dry fairly quickly, but not so quickly as to crack afterwards—that is to say, it should be dissolved in some medium which does not evaporate very quickly; with this the brush must always be cleaned after use. A very light ring is put on first, to be followed by further applications after the drying of the previous coats; the later applications are only for the purpose of making it possible to polish the slide with a cloth before examining the object without

fear of detaching the cover-glass. The danger that it will move at all, after the jelly has once cooled, is very slight, unless the slide is warmed. Zinc oxide varnish is to be avoided, as it is easily detached through the glycerin creeping under it. These directions may appear excessively detailed, but radulæ being sometimes relatively thick objects, they require special care in order to make the preparations reasonably lasting. It is, in fact, a method in which there is no room for imperfections in technique. Very beautifully made all-metal turntables can now be obtained from the opticians.

Glycerin jelly mounting is commonly in use, and was employed by Dr. Gwatkin. It is easy in reality, if we take care first to find out exactly what we may and may not do. But it has some grave disadvantages. With the greatly improved objectives of the present day, and their consequent greater sensitiveness to things that are not done quite right, it may be said to be optically inexcusable.

Any resinous or aqueous medium used for mounting a radula will in time cause the object to become more transparent by actually penetrating it. This is the case, for instance, with Canada balsam; here the object becomes invisible in a week or two. It is also the case with euparal and other similar media selected to act as euparal does by contrast of refractive index; in this case the specimen may remain visible for a year or two. Radulæ in Farrant's medium take rather longer to become transparent, those in gum arabic and phenol go more quickly. In the case of species with large or thick teeth it may be even an advantage for the contrast of refractive indices to be reduced; thus *Fusus*, *Testacella*, *Oxystyla*, *Dentalium*, *Patella*, *Doris*, or *Aplysia* may appear to remain unchanged in any of these media. But if, after the lapse of some years, a second specimen is mounted in the same way for comparison, it will be found that the older specimen has become appreciably more transparent. The penetration is a real difficulty with species having very minute structure or very thin unci. These are not necessarily very small species. *Ashfordia granulata* is a case in point. The admedian teeth are well seen and can be photographed by difference of refractive index; the externals after a time require the use of the Abbe apparatus (lateral illumination) to explain their structure. Still more is this the case with all the small Planorbes; indeed, their real structure simply cannot be made out, and has, in fact, never been correctly described or figured. Now, it is quite easy to show that the structures thus badly seen are nowhere near the physical limit of resolution: we could easily see them if the conditions of visibility allowed the use of a larger numerical aperture. This the stained object allows. The methods of colour difference and refractive index difference cannot be successfully combined because they demand different microscopical treatment.

Visibility obtained by mounting the object in a medium of higher refractive index is open to the same objections, but permits of the use of a higher N.A. Substances suitable for such a medium are not common. Gum styrax may be used. It is a treacly mass, opaque and resembling the

mud of the Tigris in appearance. By shaking it with xylol and evaporating the filtrate one obtains a clear orange-coloured resinous mass, which is then dissolved in about its own volume of naphthalin monobromide. This plan is much better than making an alcoholic extract, as the xylol picks up very little water. When observed in the microscope, the radula mounted in this medium is less solid-looking than it would be in glycerin jelly, but the definition is much better, and there is greater definition in depth, while the structures provide optical puzzles of a different kind. It usually takes a long time for penetration of the object to take place, and when it does there is no difficulty in removing the medium with xylol and remounting. No ringing is required. But by the use of stained specimens in Canada balsam the optical puzzles may be entirely avoided, and the full aperture of good objectives employed.

IV.

Some account of staining processes will follow. This section contains selected results of hundreds of experiments, successful methods being chosen. Researchers, however, will agree that it is often possible to get more interesting results from a failure than from a success.

The substance of the radula is formed of two materials : the chitin, which is an organic product, staining with acid dyes, just as desquamated epithelium does ; and the enamel, an inorganic compound or mixture containing calcium, phosphoric acid, and a little iron, and staining under favourable circumstances with basic dyes. The composition was worked out by Professor Bergemann, on behalf of Troschel, before 1856. The distribution of the two main ingredients is correctly described in Rössler's paper (1885), in which is described the development of the organ. No stain under ordinary circumstances will stain the whole of the radula ; nearly all stains may be regarded as tests either for chitin or for the enamel. A doubly stained radula, therefore, has some scientific value, and an interesting research might be made into the relative distribution of these two ingredients in different species. The radula consists of four regions, arranged in this order from behind forwards : (a) unci composed of chitin only ; (b) unci composed of chitin with the beginnings of the enamel spread over it ; (c) unci covered with enamel, but hidden during life under the secreting blanket of epithelium ; and (d) the region of fully-formed teeth covered with enamel and in active use ; many of these last will be found chipped and worn, more especially in the front. By decalcifying reagents, such as are used for bone in histological sections, we can strip off the enamel coating and leave the unci in regions *c* and *d* greatly diminished in thickness.

But a slight degree of decalcification with very dilute hydrochloric acid leaves the exposed surface of the enamelled uncus in a favourable condition for penetration by an acid azo dye, such as brilliant black or bieberich scarlet. These dyes also stain the same parts when applied to specimens which have been for some time (months or years) in glycerin jelly ; but when applied to

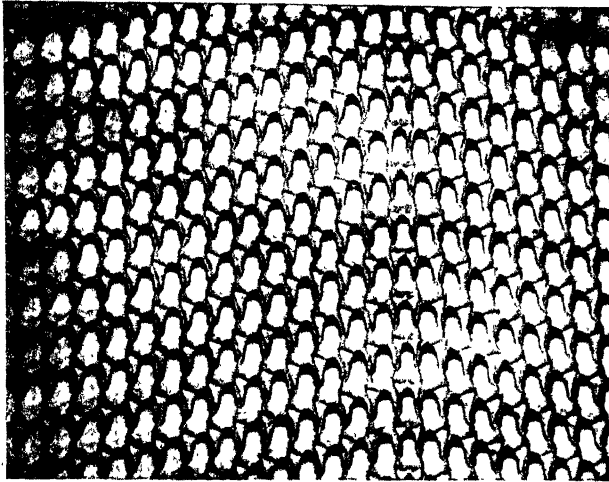


FIG. 8.

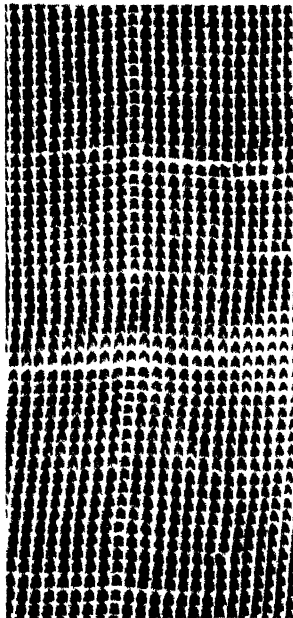


FIG. 9.

fresh radulæ they act only as acid dyes. When staining with these acid dyes, the process may be quickened and intensified by heat; it is a good plan to boil the radula in a very dilute solution of the dye, only enough being present to tinge the water; thus the staining process can be seen. On the other hand, boiling prevents the deposition of basic dyes in the enamel, even though they are present in strong concentration; while in the cold they may be seen to go into the enamel from a dilute solution, just as the acid dyes do with the aid of heat. Acid stains in general, including the azo series, when applied to the fresh radula, give the same effect that is obtained by the polariscope, i.e. they show up the chitin. The effect given by the stains is preferable, and usually much more intense. The thick teeth of the whelk and other classical polariscope objects, containing more of the organic and less of the inorganic constituent, stain brilliantly and easily in all acid dyes, whether in acid solution or not.

Numerous efforts have been made to secure the staining of radulæ with various preparations of carmine. But carmine is really an acid dye, only securing basic staining in histology by regressive methods. The laboratory carmines stain as acid dyes. Hæmatoxylin does not stain well in a very acid solution, but after treatment with permanganate it gives a good and fast stain. The method is to give successive doses of weak permanganate solution till the teeth of the radula appear quite black, then to bleach them in extremely dilute oxalic acid, using a little gentle heat to start the evolution of carbon dioxide, then to wash in distilled water, and finally add the basic dye in a diluted condition. After this process acid dyes give only a weak stain, usually washed out by the alcohol, and the polariscope no longer shows up the chitin. Indeed, the process may be regulated by watching for the disappearance of the polariscope image. If the treatment is carried on much beyond this point, the attachments of the unci to the basement membrane become weakened, and the membrane itself may drop to pieces. Other oxidising agents, such as chromic acid, have the same effect when their action is carried far enough. A moderate treatment with chromic acid is useful when preparations showing isolated and partly isolated unci are required. It was once recommended to use chromic acid as a stain for radulæ; the idea seems optimistic, but the species on which it was proposed to use it were small pectinibranchs, which have much chitin and little enamel. The best stain to use after the permanganate process is dahlia.

Picric acid may be usefully combined with an acid stain to produce a double stain; indigo carmine, acid fuchsin, and brilliant black can be applied in this way. The greater part of the picric acid will disappear during the subsequent washing. It appears to act partly as a decalcifier and partly as a penetrator of chitin. It gives good results with the *Limnæidæ*, which have a more chitinous type of radula, and are difficult to deal with on account of their general fragility. Chrysoidin does not stain them with as much precision as might be desired, which corresponds with the fact that

chrysoidin is a stain for the enamel, and in these species (nearer in descent to marine forms) there is very little enamel.

The only dye which is satisfactory for the enamel and the enamel only, without any previous preparation of the radula, is chrysoidin. Further search may produce another stain having this desirable quality, but it has not been found yet. It is excellently suited for photography with yellow-sensitive plates, and all the stained radulæ reproduced in the plates at the end of this paper were stained with it. For visual observation it is advisable to interpose a screen of blue-green tinge; a suitable one in glass is provided by Messrs. Leitz.

One other method may be mentioned for its simplicity; it may have value also, because it shows form only, and is not concerned with reaction. If the balsam is coloured with black asphalt varnish or any other black or dark material in sufficiently fine particles which will make a good mixture with balsam, the object may be covered with a drop of this mixture instead of the usual balsam for mounting. When the cover-glass is pressed down on the object, the latter will be seen as a white or brownish object on a dark ground. The darkness of the ground may not be very great; it is usually sufficient if the contrast is as great as in a negative of the type which would be preferred for enlarging. As the image itself is negative, it may be used for making direct positives in the camera. It would be best suited for radulæ which are nearly flat when laid out on the slide, thus approximating to the conditions of Burri's method, which suggested it.

V.

The first aim of the naturalist is to record. Records are necessary for subsequent identification and comparison, and to give a general map of the subject in hand. The actual specimen, if it can be satisfactorily preserved, is the best record possible, and hence we make collections. Sometimes we have to be content with descriptions. In the case of many classes of natural objects, descriptions are of very little use, and might be abolished without any injury to the progress of science. A few notes appended to a good figure are all that is required. Some things can be counted, being made up of distinguishable units, and a numerical record will always have value, whether we use it as a basis for sums and formulæ or not. Drawings are far better than descriptions of form, which are really a kind of poetry, and lead to artistic exaggeration. But though drawings are better, the draughtsman is also an artist, and often frankly exaggerates in a good cause. He is a particularly dangerous person when he has to delineate things whose precise nature he does not yet know. All this fits the case of radulæ perfectly. Having drawn many pictures of them myself, I know how unreliable pictures are, even the best, such as Lovén and Hugo Troschel could draw. Hence photography is really the only eligible method for making our records. They can be reproduced now with a degree of excellence which was undreamed of

but a short time ago. The whole of the photographic and photomicrographic art has brightened up wonderfully during the last few years. For much of this we have to thank the present tenant of our Society's presidential chair. "Homals" now allow us to get a flat field with medium and high powers, formerly only possible with Planars. Screens and colour sensitive plates of every kind are no longer understood and used only by the learned. It is not too large a claim to make that photography is essential to the comparative study of microscopic objects—in particular, of radulæ.

NOTES ON THE ILLUSTRATIONS.

These illustrations have been selected in order to show that the method of staining and mounting in Canada balsam gives good photographic results, free from those uncertain or doubled lines with which photographs of glycerin jelly preparations are disfigured. These false images have proved a fertile source of error in the past, and an examination of drawings of radulæ shows that they have very often led the artist into representing "structure" which has no existence. Only one of the figures, No. 8, represents a specimen mounted in glycerin jelly (a *Cepæa*). In this case the object was first focussed on the screen so that a satisfactory image was produced; then the iris of the condenser was opened till the visible image on the screen was hardly seen at all, and the plate exposed. It will be observed that this device was completely successful, and has in this case suppressed most of the unwanted images. The photographic plate is more sensitive than the eye, not less. It should be added that a deep blue screen was used. The final result in this case is satisfactory, but the width of the unci appears greater than it is in reality. If the medium is of high refractive index (styrax in monobromide), it appears less than the reality. One unfortunate consequence of this phenomenon is that measurements of radulæ in a watery medium are all open to suspicion. Such measurements should be repeated upon specimens in Canada balsam.

Figs. 4 and 5 are reduced from photographs of *Vitrina maior* and *V. pelucida*, two species which have very similar shells and have often been confounded. They were photographed dry, without a cover-glass, with an apochromatic 8 mm. specially corrected for use in metallurgy, but in this case transmitted light was used. The objects are very small, the magnification as reproduced being 420 diameters. The basal-plates are broad (in the middle of the organ, which is here seen) and the unci are relatively thin and of peculiar shape. Consequently it is difficult to get a good picture of a stained specimen, as there is very little enamel to stain. False images prevent any fair view of the teeth if the method of differing refractive indices is used. Observing through the microscope, we find different images at every slight change of focus. The dry mounting method settles these difficulties. It may also be used for obtaining photographs of blood films without a cover-glass, the contours of the corpuscles being recorded with the greatest ease. In

this case again it is important to give a larger aperture than seems required by the screen appearances.

All the other figures are from specimens stained with chrysoidin and mounted in Canada balsam. No. 1 shows a small part of the radula of *Umbrella mediterranea* at 75 diameters. It is taken from a whole-plate negative, which includes perhaps a sixteenth part of the whole specimen. These teeth are literally counted by millions. The individual teeth are the little dark lines, curved and resembling blades of grass. The basal-plates are not shown, being scarcely stained. In a slide in which both are visible simultaneously the result is a very decided confusion.

No. 2 shows a native species, *Hyalinia lucida*, magnification 78. Here are some very large teeth with heavy coating of enamel, and also small and evanescent central rows. It would take but little more development to obliterate the central ones, but actual absence of them is extremely rare. In nearly all those species in which they appear to be absent (such as the violet sea snail *Ianthina* and some *Testacellæ*) the centrals can at once be demonstrated by chrysoidin staining; otherwise they could not be distinguished from an accidental fold in the membrane.

No. 3 is the common snail, *Helix aspersa*, x 112. As before, only the central part is shown. This was taken with the Zeiss aa objective, and illustrates the fairly flat field which this objective gives; the original is on a whole plate, and the plate is covered.

Nos. 6 and 7 are two *Hyalinix* in which the structures may be compared with that of fig. 2. The shells of the three species are similar in appearance, but the radulæ are unmistakable in each case. These two are smaller species, and the magnification is about double that used for fig. 2; in these small forms the teeth are more nearly equal in size; the exaggeration of the size of the side rows is not so marked, but the evanescence of the central tooth is still to be noticed. If it is desired to obtain a picture in which the outlines of the basal-plates are clearly seen, as though the whole structure was composed of glass, but avoiding the internal reflections which would be so serious a bar to the interpretation of the shape if the method of differing refractive index were used with these transparent objects, a satisfactory picture can be made by the acid staining process already described, using, e.g., biehrich scarlet as the dye. The radula will not be a good object for the ordinary visual examination, except in those parts where the red-stained teeth do not happen to have red-stained basal-plates immediately behind them. But if the object is photographed with a red screen of appropriate intensity, so as to almost obliterate the appearance of the structure on the screen of the camera, it will be found that the plate has again done what the human eye cannot; it will pick out the image so that it looks like an outline drawing, but has none of the bewildering complications which result from internal reflexion in the constituent parts of the object. We can do much by employing similar coloured screens for the reduction of contrast. Fig. 2, for instance, though stained with chrysoidin, was taken with an orange

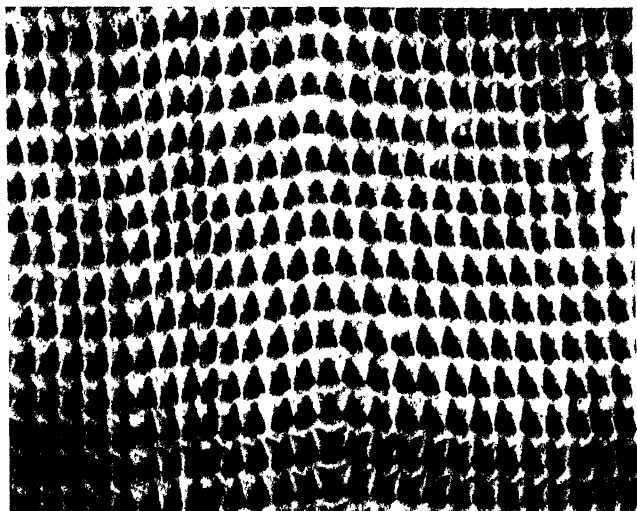


FIG. 10.

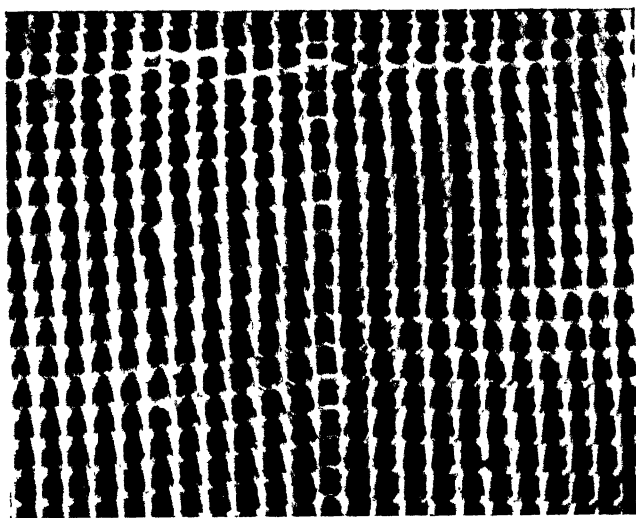


FIG. 11.

screen (not deep enough to obliterate the contrast). For such purposes it is often useful to employ a glass screen, which rarely gives so complete an exclusion of light of other colours as do the gelatine screens. Chrysoidin specimens are rendered on "ordinary" plates merely as black silhouettes, which would be of little use. Figs. 6 and 7 were taken upon Agfa film, which is yellow sensitive, and a light orange screen was used. Film packs are very useful when a series of photographs are to be taken for comparison under exactly similar circumstances of exposure, magnification, and lighting. They can all be developed together in a tank, and the time spent upon producing the series is greatly shortened.

Figs. 9, 10 and 11 are from some probably undescribed species of desert Helices sent to me for examination by M. Paul Pallary, of Oran, in Algeria. The teeth are noticeably less regular in arrangement and more subject to abrasion than those of our garden snail, to which they are fairly closely related. In No. 11 the side cusps are hardly visible, but the photographing of a large area of the specimen shows without any doubt that they are really there, though concealed by the heavy enamel coating which is presumably designed to deal with desert products. The study of unknown objects which differ to a slight degree only among themselves is far better carried out by photographing them. The photographic picture can be made to give a far larger field than the visual field of the microscope when the same numerical aperture is employed in both cases. The magnification of fig. 9 is 58.5; it is taken with a 20 mm. planar, a Zeiss green glass screen, and the x 10 lupe as condenser. The other two are magnified 126 diameters, and the objective was an old C, with a special lens attached at the back to make its posterior focus one metre. This plan, of course, is not to be compared with the use of the Homals.

REFERENCES.

1. ARISTOTELES. Hist. Anim., 4, 4, 7. (Tauchnitz ed., p. 231.)
2. LISTER, M.—"Exercitatio anatomica." Londini, 1694, 1695.
3. ADANSON.—"Histoire naturelle du Senegal." Paris, 1757.
4. THOMSON, W.—"Remarks on the Dentition of British Pulmonifera." A.M.N.H. Ser. II, 7, 86-94.
5. LOVÉN, S. L.—"Om tungans beväpnning hos Mollusker." Öfv. K. Vet-Akad. Förhändl. 1847, 175-199, 5 plates.
6. GRAY, J. E.—"On the Teeth on the Tongues of Mollusca." Q.J.M.S., 1, 1853, 170-176.
7. TROSCHEL, F. H.—"Das Gebiss der Schnecken." Berlin, 1856-1863.
8. ——— and THEILE, J. (Completion). Berlin, 1866-1893.
8. RUECKER, A.—"Bildung der Radula bei *Helix pomatia*." Ber. Oberhess. Gesell. 22, 1883, 209-29.
9. ROESSLER, R.—"Bildung der Radula bei den Cephalophoren Mollusken." Zeit. f. Wiss. Zool., 41, 3, 1885, 447-82.

ABSTRACTS AND REVIEWS.

ZOOLOGY.

(Under the direction of G. M. FINDLAY, M.D.)

STAINING AND IMPREGNATION METHODS.

A Modification of the Da Fano Technique.—S. W. YABROFF (*Trans. Am. Micr. Soc.*, 1928, 47, 95-98). This modification is adapted for protozoan nerve elements and fibrillar structures. Impregnation in the Da Fano method is accomplished in 24 to 28 hours in a 1.5 p.c. solution of silver nitrate. The modification makes use of a weaker solution (0.1 p.c. silver nitrate) for 10 to 24 days, which allows a more delicate impregnation for the finer cytological structure. The material is toned in a 0.1 p.c. solution of gold chloride and hardened with a 1 p.c. solution of hyposulphite, in contrast with the 2 p.c. solution of gold chloride and 5 p.c. solution of sodium hyposulphite of the Da Fano method. G. M. F.

Giemsa Staining of Blood Preparations.—E. J. COENAES (*Nederland. Tijdschr. Geneeskunde*, 1927, 71, 1934-38). The stain should be kept in a tightly-stoppered bottle and at room temperature. The stained preparation should be rinsed with a buffer solution of pH 6.8-7.1 consisting of 1 gm. of potassium di-hydrogen phosphate and 2 gm. of disodium mono-hydrogen phosphate. The dye solution should also be diluted with this buffer mixture. A. H.

Immersion Fluid.—S. H. BERTRAM (*Chem. Weekblad.*, 1928, 25, 24). The following mixture, when warmed, treated with a little fuller's earth and filtered, has the same refractive index as cedar oil: 35 parts pale colophony, 15 parts of naphthalene, and 50 parts of sesame oil. A. H.

Variable Results with Flagella Stains.—W. H. WRIGHT ("A Discussion of Some of the Factors causing Variable Results with Flagella Stains," *Stain Technol.*, 1928, 3, 14-27). No method of staining flagella is available which gives consistent results in the hands of all workers. Many mordants change rapidly both chemically and physically after preparation. Complicating factors, such as temperature, oxidation and reduction, the age of the bacterial cultures, and species variation, are discussed. G. M. F.

Stain Solubilities.—W. C. HOLMES (*Stain Technol.*, 1928, 3, 12-13). The solubility in water and 95 p.c. alcohol of 45 stains is given. All attempts to determine the aqueous solubilities of Biebrich scarlet, Congo red and purpurin 4B proved unsuccessful, as when freed from inorganic salts these dyes yield colloidal solutions. G. M. F.

Metallic Lakes of the Oxazines.—F. PROESCHER and A. S. ARKUSH ("Metallic Lakes of the Oxazines (Gallamin blue, galloxyanin and Cœlestine blue) as Nuclear Stain Substitutes for Hæmatoxylin," *Stain Technol.*, 1928, 3, 28–38). Becher (1921) found that certain oxyanthraquinone dyes form soluble lakes with certain metallic salts. They thus give nuclear stains which in brilliancy and resistance are far superior to hæmatoxylin. Gallamin blue, galloxyanin and cœlestine blue dissolved in a 5 p.c. aqueous solution of ferric ammonium sulphate give the best results. The iron lakes of these dyes stain nuclei in from three to five minutes, giving a deep blue or blue-black colour. The protoplasm remains practically colourless and can be counterstained with any of the usual acid stains. Fat stains, such as Sudan III or Scharlach, may also be used. All the common fixatives may be used, and the method is especially suitable for the central nervous system, ganglion and glia cells being stained as excellently as with thionin.

G. M. F.

The History of Staining.—H. J. CONN ("The Pioneers in Staining," *Stain Technol.*, 1928, 3, 1–11). Although Gerlach (1858) was probably the founder of modern histological staining technique, the earliest work of this character was carried out by an Englishman, G. M. Smith, who, in 1770, published a book, "The Construction of Timber, from its Early Growth: Explained by the Microscope, etc.," London. Smith used an alcoholic tincture of cochineal for staining. He also employed a mordanting method. Sugar of lead was dissolved in a teacupful of water, and the portions of wood soaked therein for two days. A solution of quicklime and orpiment in water was then prepared and the material from the teacup was transferred to this for two days. In a short time the sticks of wood became deep brown. Another method was by boiling the dried wood in green sealing-wax, "so that they became thoroughly impregnated with the green sealing-wax, and the split pieces resemble striped satins in a way scarce to be credited." Ehrenberg (1838) studied infusoria and bacteria by means of carmin, but Corti (1851), in studying the epithelial lining of the cochlea, seems to have been the first to obtain differential staining, though he attached little significance to his results. Real advances were, however, made by Hartig (1854) on botanical material, and by Gerlach (1820–96) with animal material. Following 1860 modern histological methods came into use. Anilin dyes were first employed in histology by Beneke (1862), logwood extract by Waldeyer (1864) in an attempt to stain axis cylinders, and crystalline hæmatoxylin by Böhmer (1865). It is a little difficult to realise that staining methods in histology are less than a century old.

G. M. F.

GENERAL CYTOLOGY.

Position of the First Cleavage Spindle of Sea-Urchin Eggs.—G. FADDA ("Die Richtung der ersten Furchungsspindel bei Seeigeleiern in Röhrchen," *Wihl. Roux' Arch. Entwicklungsmech.*, 1926, 107, 202–12, 9 text-figs.). Under the influence of gravity the first cleavage spindle stands at an angle of 45° to the horizontal when the eggs are in capillary tubes having the same internal diameter as the diameter of the egg, or having greater bore, whether the tubes are horizontal, vertical, or inclined. But the position of the spindle is not fixed, and if the diameter of the tube is less than that of the egg, the direction of the axis of the spindle approaches that of the longitudinal axis of the tubing more or less closely according to the amount of compression caused by the encircling tube, and also in conformity with mathematical formulæ worked out by Giglio-Tos, which formulæ are based on the positions of rest attained by two spheres free to move, under the influence of gravity, within a larger sphere.

Biological Abstracts.

Selective Staining of the so-called Accessory Nuclei of the Pancreas and Their Nature.—NOBUHIKO SANNOMIYA ("Über eine elektive Färbung der sogenannten Nebenkern des Pankreas, nebst einigen Bemerkungen über das Wesen derselben auf Grund dieser spezifischen Färbung," *Folia Anat. Japonica*, 1927, 5, 201-11, 1 text-fig.). The following method brings out the accessory nucleus in pancreas cells: (1) fix in 10 p.c. HCl for 24 hours; (2) wash in water and dehydrate with alcohol; (3) stain sections in 1 p.c. acid-fuchsin 3-5 minutes; (4) wash in water, differentiate with a saturated solution of picric acid, and wash again; (5) place sections in 1 p.c. phosphomolybdic-acid solution for 1-2 minutes; (6) wash, dehydrate and clear with xylol. By this method the accessory nucleus is a bright, deep red colour, readily recognised against the yellow remainder of the cell. It is better, however, to stain the sections with hæmatoxylin previously, or to double stain with light green or aniline blue afterward, in order to differentiate more clearly. The author concludes that the accessory nucleus is not an artificial product; it is spheroidal with very smooth contour; its staining reactions are quite different from those of the chromatin or the nucleolus; structurally it is entirely different from zymogen granules, prezymogen granules, mitochondria, basal filaments, or ergastoplasma, etc., and represents a specific acidophil corpuscle, and that Nebenkern is a misnomer. *Biological Abstracts.*

The Chromosome Cycle of Urospora.—A. NAVILLE ("Le cycle chromosomique d'*Urospora lagidis* (de Saint Joseph)," *Parasitol.*, 1927, 19, 100-38, 10 text-figs.). The diploid number of chromosomes in this gregarine was found to be 4. The author divides the development of gametes into 4 phases, each characterised by a type of mitosis. The first is an equational division in which the duplication of chromosomes occurs in the prophase. In the second stage the chromosomes do not split until the metaphase. The third phase exhibits heterotypic division in which the chromosomes are reduced to the haploid number (two). The fourth and last type of division is homeotypic. The fusion of the gamete nuclei in the zygote is followed by a conjugation of chromosomes similar to synapsis in higher forms, after which multiplication is by equational division. Consequently, *Urospora* exhibits gametic and not zygotic meiosis. *Biological Abstracts.*

The Chromosomes of Rodents.—T. S. PAINTER (*Sci.*, 1926, 64, 336, 5 text-figs.). This article summarises the essential results obtained to date by a study of the chromosomes of different rodents at the University of Texas. The house mouse (worked out by E. K. Cox) has 40 spermatogonial chromosomes. The reduced number is 20, which includes a typical X-Y sex chromosome complex. The albino rat (worked out by I. Kehoe) has 42 spermatogonial chromosomes. The reduced number is 21. The indications are that here again an X-Y sex chromosome complex is present. The guinea-pig (worked out by B. League) shows between 60 and 64 spermatogonial chromosomes. The best haploid counts give 30 as the reduced number. Sex chromosomes were not definitely identified. The rabbit (by the author) possesses 44 spermatogonial chromosomes; the reduced number is 22, including an X-Y complex. *Biological Abstracts.*

The Nucleolar Substance During Growth of the Oocyte.—R. G. MOSELLA ("Über einige Veränderungen der Nucleolarsubstanz während des Wachstums des Oocyten und des Eifollikels bei *Lacerta muralis*," *Anat. Anzeiger*, 1926, 62, 76-93, 1 pl.). Häcker's theory as to the importance of nucleolar substance, that the nucleolus is a metabolic product dependent on the activities of the nucleus, is discarded in favour of that of Jörgensen, according to which the nucleoli are regarded as organelles actively functioning during growth. Observations on the

growing oocytes of *L. muralis* are in agreement with these conclusions. The oocyte during growth manifests certain stages which are distinguishable, not only by size, but by changes in the germinal vesicle and in the nucleoli; nine stages are thus described. The remainder of the paper is devoted to the study of follicle cells during growth of the oocyte. Their origin, their method of growth, the manner in which ergastoplasmatic granules are accumulated in them and transferred to the growing oocyte, are described.

Biological Abstracts.

Internal Structure in the Cells of Some Organs of Man.—F. KOPSCH ("Das Binnengerüst in den Zellen einiger Organe des Menschen," *Jahrb. Morph. u. Mikrosk. Anat.*, II, 1926, 5 (Festschr.), 221–84, 38 text-figs.). The material was from two men, one 22, the other 44 years old, and fixed by the Kopsch-Kolatchev method. The cells of which the internal structure is described are spinal and sympathetic ganglion, epithelial of the lateral ventricle of the choroid plexus, epithelial of tracheal glands and their secretory passages, of the ciliated epithelium of trachea, of gastric epithelium, of fundus glands, of Brunner's glands and their secretory passages, of intestine (both cylinder and goblet), glandular of pancreas, epithelial of prostate, scrotum, and of Cowper's glands and their secretory passages. A review is given of the literature on the relation between internal structure and glandular secretion, and also on chemical composition of the materials of the internal structure.

Biological Abstracts.

Variation in Nuclear Size.—W. JACOBI ("Die Veränderung der Kerngrösse in der Spermatogenese und der Vorgang der 'inneren eilung' bei den Spermatosyten," *Verhandl. Anat. Ges., Jena*, 1926, 1926, 222–33). Many nuclear measurements were taken in an attempt to prove the protomere theory of cell growth advanced by Heidenhain. The nuclear volumes of the liver cells of a mouse were found to have the size relationship of 1:2:4:8 to each other. The nuclear volume of the germ cell in its various stages shows a definite relation to the chromosome number. Variation in the nuclear volume is shown by six curves. The article is followed by a short supplement on the question of cell growth, function, and the protomere theory.

Biological Abstracts.

Heterochromosomes in the Earthworm *Allolobophora foetida* Eisen.—L. MONNÉ (*Bull. Internat. Acad. Polonaise Sci. et Lettres, Ser. B. Sci. Nat.*, 1926, 1925, 979–992, 1 pl.). Monné agrees with Foot and Strobell that there are 22 chromosomes in the gametogonia and 11 in the gametocytes, but differs somewhat from them in interpretation. He considers that both spermatogonia and oogonia contain two X's. This conclusion is based principally on the slightly precocious division of one pair in the first spermatocytes. All gametes are similar in their chromatin constitution. Over half of the paper is a review of the literature bearing on the behaviour of the chromosomes in hermaphroditism.

Biological Abstracts.

Sex Chromosomes in the Domestic Fowl.—R. T. HANCE (*Journ. Morph. & Physiol.*, 1926, 43, 119–45, 4 pls., 1 text-fig.). The chromosome number is approximately 35 or 36. It is difficult to determine the exact number, owing to the smallness of the shortest chromosomes of the complex and also to the tendency of the chromomeres to occasionally appear as discrete chromosomes rather than as parts of a whole. Difficulty experienced in fixing adult testes has prevented a satisfactory demonstration of all stages of spermatogenesis. However, satisfactorily preserved prophases of first spermatocytes have been observed which together with the large amount of embryonic material available, have made it

possible to work out the behaviour of the sex-associated chromosomes with reasonable certainty. Measurements indicate that the longest chromosome in the cell is single in the ♀ and paired in the ♂. Two classes of eggs are therefore possible—one with and one without this long chromosome—while all the spermatozoa produced are alike in possessing the long chromatic element. The ♀ is therefore heterozygous and the ♂ homozygous in regard to this chromosome, a cytological parallel for the genetic evidence of the heterozygosity of the ♀.

Biological Abstracts.

The Physico-chemical Characteristics of Sexuality and the Problem of Cell Multiplication.—P. JOYET-LAVERGNE ("Les caractères physicochimiques de la sexualité et les problèmes de la multiplication cellulaire," *Rev. Gen. Sci. pures et appl.* 1927, 38, 141-43). Sexualisation of the cytoplasm is dependent upon certain physico-chemical factors. In any given species the cells which are to be ♂ have a greater oxidation-reduction value than cells which are to be ♀. ♀ cells acquire a reserve of fats and lipoids which reduce osmic acid, while cells which are to develop into ♂ gametes lack this quality. The increase of fats and lipoids, and the transformation of the nutritive materials at the disposal of the cell into fats and lipoids, are correlated with decrease in the power of cell multiplication.

Biological Abstracts.

The Chromosomes of the House Mouse.—E. K. COX (*Journ. Morph. & Physiol.*, 1926, 43, 45-53, 2 pls.). The spermatogenesis of the domestic mouse has been studied. There are 40 chromosomes in spermatogonia and 20 in primary spermatocytes. The sex chromosomes are of the usual X-Y type. Special attention has been devoted to the study of chromosome morphology, both in spermatogonia and in primary spermatocytes.

Biological Abstracts.

Cytological Studies on Embryonic Pancreas.—J. ARIMA ("Die zytologischen Untersuchungen der Baucheingeweide beidem Embryonen I. Mitteilung. Die Studien über das Pankreas," *Folia Anat. Japonica*, 1926, 4, 305-36, 20 text-figs.). A study on mouse embryos (1.2, 1.7, 2.1 cm.), young mice (seven days old), and human embryos (1.5, 8, 23, 32, 51.5 cm.), leads to the following conclusions:—Generally, in acinous cells of the pancreas of human and mouse embryos granules are found which cannot be taken for chondriocents. They are secretion granules which grow with development of the cells until they have light halos around them. The chondriocents are first seen in the new-born. The granules play an important part in the secretion product, but the author disagrees with those who hold that they are formed from chondriocents. No intimate relation has been noticed between the nucleus and the secretory process. In cells of the Langerhans islet of mouse embryos (1.2 cm.) are seen small and very short bacillary bodies and a small number of minute granules. A few loosely scattered granules are met with in 1.7-cm. embryos, and very small granules in 2.1-cm. mouse embryos, young mice, and human embryos. The granules, as a rule, increased with development of the cells. Reticular structure is seen in the cell body of the Langerhans islet where granules are not present. The author is not sure whether the islet is made up of two or more kinds of cells.

Biological Abstracts.

Quantitative Cytological Studies on the Renal Tubules.—W. P. COVELL (*Anat. Rec.*, 1926, 34, 61-73). The ratio in the albino rat varies in different portions of the renal tubule and shifts during post-natal development. In the proximal convoluted tubule it is, roughly, 1:9.5; in the distal convoluted tubule, 1:8.3; in the ascending limb of Henle's loop, 1:6.0; in the descending limb, 1:4.6.

During the first two weeks of post-natal development, the ratio in the proximal convoluted tubule is 1:7.6, and 1:5.8 in the distal convoluted tubule. In the ascending limb of Henle's loop it is 1:3.6, and 1:2.7 in the descending limb. Nuclear diameter and volume varies for each of four parts of the tubule. The mean nuclear diameter of cells of the proximal convoluted tubule is 5.5μ and about 5.6μ for the distal convoluted tubule. It is 5.3μ in the ascending limb of the loop and 5.0μ in the descending limb. Cell volume increases approximately 35 p.c. for each part of the tubule during post-natal growth. It is $973\text{ cu.}\mu$ for the proximal convoluted tubule and $874\text{ cu.}\mu$ in the distal convoluted tubule. In the ascending limb of the loop of Henle it is $532\text{ cu.}\mu$ and for the descending limb it is $385\text{ cu.}\mu$.

Biological Abstracts.

Connective Tissue Fibrillæ and Mitochondria.—E. LAGUESSE ("La première ébauche des fibrilles conjonctives provient-elle du chondriome," *Arch. Anat. Micr.*, 1926, 22, 129-75, 2 pls.). The precollagenous fibrillæ arise independently in the interior of the ectoplasm and are then able to grow indefinitely at its expense without aid of chondriosomes. Superficial chondriosomes may be engulfed in the ectoplasmic differentiation and degenerate. They may, however, be used passively as a nutritive substance. Appearance of fibrillæ may be considered as a sort of micellar crystallisation.

Biological Abstracts.

A New Finding Contrary to the Cell Theory.—B. MONTEROSSO ("Di un nuovo reperto contrario alla 'teoria cellulare,'" *Bol. Soc. Biol. Sperim.*, 1926, 1, 205-7). All organs of *Peroderma cylindricum*, a copepod parasitic on *Clupea pilchardus*, are made up entirely of a multinucleate, plasmic mass without cell walls (syncytium or plasmodium?) except the mucosa of the alimentary canal, the ovary, and the mononuclear ameboid elements wandering in the coelomic fluid. Such a prevalence of syncytial structure is contrary to all cellular theory. The author concludes that a multinucleate, plasmic mass can possess the tendency to assume at the same time the character, in homology and analogy, of a tissue.

Biological Abstracts.

The Minute Structure of Harder's Gland in the Rabbit.—H. MUKAI ("Über die feinere Struktur der Harderschen Drüse beim Kaninchen," *Abh. u. Graefe's Arch. Ophthalmol.*, 1926, 117, 243-72, 35 text-figs.). The nuclei, mitochondria, secretion granules, vacuoles and their relationships differentiate the cells of the so-called white and red portions of Harder's gland cytologically. However, the secretory processes in the two types of cells are apparently very similar, consisting of production of secretory granules, probably through activity of the mitochondria, and a series of morphological changes in the granules through vacuoles to true secretion. Staining (with Sudan III) of the secretory products of the 2-cell types indicates a slight difference in the chemical nature of their fatty secretions. Some acini occasionally are composed of both types of gland cells, and here also the 2 types of secretion may be distinguished. The cells of the red portion are distinguishable in embryos 26 days post coitus, those of the white portion about 10 hours post partum. After four and a half days both types of cells are well developed, and those of the red part are in secretory activity, the latter not appearing in those of the white portion until eight days after birth. The cells of both parts are in full functional activity at 14 days, coinciding with the opening of the eye cleft.

Biological Abstracts.

Chromosome Number in Somatic Cells of Man.—S. D. SCHACHOW ("Über die Chromosomenzahl in den somatischen Zellen des Menschen," *Anat.*

Anzeiger, 1926, 62, 122-7, 4 text-figs.). Serial sections from the chorion and decidua of 30 human embryos, two to three months old, preserved fresh in Carnoy's (6-3-1) mixture, were studied. In 107 counts the observed chromosome numbers were as follows:—16 cells showed 48, 84 showed 24, 3 showed 23, 3 showed 18-20, and 1 showed 8 elements. The true diploid number is regarded as 24; cases in which 48 were observed are interpreted as due to splitting for the ensuing division. Lower counts than 24 are probably due to errors in observation or to abnormal cells. The writer was unable to distinguish between the sexes on the basis of chromosome numbers.

Biological Abstracts.

The Golgi Apparatus in Thyroid Gland Cells.—S. SCHIMARU ("Über den Golgi-Apparat in den Schilddrüsenzellen," *Folia Anat. Japonica*, 1926, 4, 13-32, 2 pls., 15 text-figs.). The gland in 24 rabbits was stimulated to intense activity by partial extirpation, so that function of the individual cells was greatly increased, offering better opportunities for study. The Golgi apparatus shows no effect 12 and 24 hours after the operation, but on the third day its bands branch and anastomose frequently, and apparently take on more mass, the condition lasting until the twelfth day after operation. After the fifteenth day there was a return to normal. The substance, apparently secretory, produced by the Golgi apparatus increases on stimulation of the secretory activity of gland cells.

Biological Abstracts.

Narcotics on Living Protoplasm.—STANISLAW HILLER ("Action of Narcotics on the Amœba by means of Microinjection and Immersion," *Proc. Soc. Exper. Biol. and Med.*, 1927, 24, 427-8). When immersed in weak concentrations (less than 2 p.c.) of ethyl alcohol, chloretone, ether or chloroform, the amœbæ continue their movements in an expanded condition. Lethal concentrations of the narcotics cause rounding up of the amebæ and disintegration of the plasmalemma. No narcotic effects are observed by injection into the interior of the ameba. If irreversible coagula are formed, they are pinched off from the living organism. A preliminary account is given of the effect of the local application of narcotics on the exterior of the ameba.

J. L.

Picric Acid on Living Protoplasm.—H. POLLACK ("Action of Picric Acid on Living Protoplasm," *Proc. Soc. Exper. Biol. and Med.*, 1927, 25, 145). Injection of amœba with saturated aqueous solution of picric acid causes no toxic effect. If the insertion of the pipette injures the protoplasm, local coagulation occurs. The coagulated portion is extruded and normal activity resumed by the amœba. Injection with saturated alcoholic (95 p.c.) solution causes tendency to local coagulation, the coagulated portion usually being extruded. The non-toxic effects of picric acid on internal healthy protoplasm are in contrast with its extreme toxicity when applied to the surface.

J. L.

Microinjection of Living Cells.—ROBERT CHAMBERS, HERBERT POLLACK, and STANISLAUS HILLER ("The Protoplasmic pH of Living Cells," *Proc. Soc. Exper. Biol. and Med.*, 1927, 24, 760-1). A preliminary account of results obtained by injecting living protoplasm of various tissues with solutions of indicator dyes. The living protoplasm of widely differing types of cells, i.e. echinoderm ova, amœbæ, tissue and germinal cells of hecturus and frog, has a constant pH value of 6.9 ± 0.1 in the healthy condition, and of 5.3 ± 0.2 when injured. The pH value for normal and injured nuclei is the same for every cell, viz., 7.5 ± 0.1 .

J. L.

pH of Nucleus and Cytoplasm of Starfish Eggs.—ROBERT CHAMBERS and HERBERT POLLACK ("The Hydrogen Ion Concentration of the Nucleus and Cytoplasm of the Egg Cell," *Proc. Soc. Exper. Biol. and Med.*, 1926, 24, 42-3). By means of micro-injection with acid and basic dye indicators, the pH of the nucleus is found to be 7.6 to 7.8, that of living cytoplasm 6.6 to 6.8, and that of injured cytoplasm 5.4 to 5.6. J. L.

Oxygenation and Reduction by Mitochondria.—P. JOYET-LAVERGNE ("Sur le pouvoir oxydo-reducteur du chondriome," *Compt. rend. de l'Acad. des Sci.*, 1928, 186, 471-3). Acetic acid (5 p.c. aqueous solution) destroys mitochondria and destroys the sodium nitroprusside reaction for glutathion. A 2 p.c. solution of trichloroacetic acid preserves mitochondria and the sodium nitroprusside reaction. If small fragments of the fresh liver of *Rana temporaria* are placed in 2 p.c. aqueous solution of pyrogalllic acid, metal, hydroquinone or diamidophenol, it is found that after teasing the tissue the mitochondria are coloured black. Paraphenyl-endiamine or metaquinone in a 1 p.c. solution in alcohol give similar results if warmed at 50° C. This indicates the oxidising power of the mitochondria. The reducing power of the mitochondria is demonstrated by immersing the fresh tissue in a 1 p.c. aqueous solution of gold chloride. The mitochondria are stained black. G. M. F.

Cell Growth.—L. E. BAKER and A. CARREL ("The Effect of Digests of Pure Proteins on Cell Proliferation," *J. Exp. Med.*, 1928, 47, 353-70, 7 text-figs.). Pepsin hydrolytic products of the pure proteins crystalline egg albumin, crystalline edestin and purified fibrin are utilised by fibroblasts for their proliferation. The digests of pure proteins employed are deficient in certain substances, and do not meet the entire nutritive requirements of the cells for an unlimited period of time. Some supplementary nutritive substances are present in fresh embryonic heart tissue. This explains the growth of fibroblasts from fresh embryonic heart in digests which do not promote the growth of a pure strain of fibroblasts. Glycocoll and nucleic acid have been found to supplement the nutritive action of pure protein digests for sarcomatous fibroblasts and to increase greatly the length of life of the tissues. Vegetable proteins, as well as animal proteins, yield proteolytic products which promote the multiplication of fibroblasts. G. M. F.

Cell Growth and Liver and Pituitary Digests.—L. E. BAKER and A. CARREL ("The Effect of Liver and Pituitary Digests on the Proliferation of Sarcomatous Fibroblasts of the Rat," *J. Exp. Med.*, 1928, 47, 371-8, 4 text-figs.). Sarcomatous fibroblasts of the rat grow in vitro in a medium prepared by digesting calf liver or anterior pituitary lobe in pepsin. The nutritive action of the pituitary digest is not destroyed by thorough extraction with ether. G. M. F.

Tissue Cultures of *Oryzias Latipes*.—Y. ONO ("The Behaviour of Cells in Tissue Cultures of *Oryzias latipes*, with special reference to the Ectodermic Epithelium," *Annot. Zool. Japonenses, Tokyo*, 1927, 11, 145-50, 1 text-fig.). Tissue cultures of the embryos of *Oryzias*, a common freshwater fish in Japan, are described in Locke-Lewis salt solution. G. M. F.

Cell Permeability and Hydrogen Peroxide.—D. L. THOMSON ("The Effect of Hydrogen Peroxide on the Permeability of the Cell," *Brit. J. Exp. Biol.*, 1928, 5, 252-7). Experiments on plasmolysis, permeation of alkali and hæmolysis do not confirm the view that hydrogen peroxide plays a specific part in the physiological control of permeability. G. M. F.

Feulgen's "Nuclealreaktion."—R. J. LUDFORD ("Studies on the Microchemistry of the Cell. I. The Chromatin Content of Normal and Malignant Cells as demonstrated by Feulgen's 'Nuclealreaktion,'" *Proc. Roy. Soc. B.*, 1928, **102**, 397–406, 2 pls.). The thymus-nucleic acid protein complex (chromatin) of animal cells is demonstrated by this method. During oogenesis in the rat and mouse there is no increase in the chromatin content of the nucleus. When the germinal vesicle breaks down to form the chromosomes, no chromatin is extruded into the cytoplasm. After secretory activity the nuclei of gland cells often become shrunken and irregularly lobulated. There was no relationship between the amount of chromatin in the nucleus of a tumour cell and the rate of growth of the tumour. Nuclear extrusions which are common in some tumours and during keratohyalinisation are composed of nucleolar material, not chromatin.

G. M. F.

Cytology of Vaccinia.—R. J. LUDFORD ("Cytological Studies on the Viruses of Fowl-pox and Vaccinia," *Proc. Roy. Soc. B.*, 1928, **102**, 406–18, 5 pls.). Virus bodies produced by vaccinia in epidermal cells of the skin and cornea of the chick have the same origin, development, and structure as the virus bodies in fowl-pox. Vaccinia virus produces in epidermal cells of the cornea of the rat inclusions closely resembling those formed in the cornea of the chick, but differing in the absence of an osmophil covering. There are also formed in cells immediately surrounding the centre of the vaccinia lesion, clusters of granules (Schütz's granules) which are the result of the infection of cells of the regenerating epidermis.

G. M. F.

VERTEBRATA.

Histology.

Fat and the Thyroid.—R. H. JAFFÉ ("Fat Contents of Pathological Thyroids in Man—Histologic Studies," *Arch. of Path. and Lab. Med.*, 1928, **5**, 13–22). Simple, diffuse, parenchymatous and colloid goitres do not differ in their lipid content from the normal thyroid. Adenomata are usually rich in fat, while in exophthalmic goitre the fat is usually decreased.

G. M. F.

The Thyroids of Pigeons.—O. RIDDLE ("Studies on Thyroids," *Endocrinology*, 1927, **11**, 161–72). The thyroids of various species of pigeons undergo a functional enlargement during the autumn and winter months, and a progressive decrease in size during the months of spring and summer. These changes follow as prompt responses to the external temperature. In various kinds of doves and pigeons both testes and ovaries enlarge during the spring and summer and decrease in size during the autumn and winter. This is precisely the reverse of the seasonal size changes in the thyroids of these same animals. Races of doves characterised by large thyroid size and other races with a small thyroid have been successfully established.

G. M. F.

The Suprarenal Glands in Borna's Disease.—S. NICOLAU ("Les modifications histopathologiques des capsules surrénales et des glandes salivaires des lapins morts d'encéphalomyélite enzootique expérimentale (maladie de Borna)," *Compt. rend. de l'Acad. des Sci.*, 1928, **186**, 655–6). In rabbits dying from Borna's disease the suprarenals contain the virus. The ganglion cells found in the suprarenals contain intranuclear oxyphil corpuscles and are the only cells which are infective.

G. M. F.

The Suprarenal Glands in Rabies.—Y. MANOUELIAN and J. VIALA ("Cellules nerveuses et virulence des glandes surrénales," *Compt. rend. de l'Acad. des Sci.*, 1928, 186, 327–8). In rabid animals the suprarenal glands are only infective when true nerve ganglion cells are embedded in the tissues of the gland. G. M. F.

Thyroid Follicle of Man.—G. E. WILSON ("The Thyroid Follicle in Man: its Normal and Pathological Configuration"), *Anat. Rec.*, 1927, 37, 31–62, 14 figs.). The normal thyroid follicle is a more or less discrete, round, oval or budded structure, averaging 300μ in diameter. In multiple colloid adenomata of the thyroid, or in diffuse colloid goitre, the follicles retain their normal shape, but may increase three to five times in size through passive dilatation, coalescence, or budding. The follicles in primary parenchymatous hyperplasia (exophthalmic goitre) are midway in size between normal and colloid goitre follicles. The outside of the follicle is normally shaped, whereas the inside is very rough and unequal, because of the hyperplastic papillary infolding. In malignant disease of the thyroid gland the follicles are frequently elongated, often compressed, and frequently no longer discrete. They may attain a length of 800μ or more. Irradiation causes proliferation of the stroma with compression of the follicles and desquamation of the epithelium, but otherwise the shape of the follicle is not altered. The lobules of the thyroid gland are not discrete, but may, and do, frequently communicate with one another. The arterial anastomoses found within adenomatous thyroid glands are believed to be present in normal glands. Histological observation of 400 normal and pathological thyroid glands with 10 wax reconstructions have failed to show any coiled cylindrical columns of epithelium lying within a fibro-elastic capsule forming a lymph sinusoid. R. J. L.

Embryology, Evolution, Heredity, etc.

Cryptorchid Testis of the Horse.—J. E. NORDBY ("Spermatogonium and Spermatocyte Degeneration in Cryptorchid Testis of the Horse," *Trans. Am. Micr. Soc.*, 1928, 47, 54–67, 4 pls.). The seminiferous tubules in the cryptorchid testis were much smaller and somewhat more tortuous than in the normal testis. Only spermatogonia and primary and secondary spermatocytes were present, and, from the point of view of number, were present in the order named with relatively a small number of spermatocytes. No mature spermatozoa were found in the cryptorchid testis. Breaking up of the nuclear material indiscriminately, closely followed by the coalescing of the nuclear wall, were unmistakable signs of early degeneration. Intermediate stages were marked by amoeboid forms of the nuclei and further disassociation of chromatin material. Cells undergo degeneration in the epithelial layer as well as in the lumen. Germ cells in the process of transformation were not affected during this activity. The secondary and primary spermatocytes appeared subject to degeneration respectively before the spermatogonia, which seemed to be affected to a somewhat smaller degree. The cells persisting longest were near the tubule periphery. G. M. F.

Accelerated Amphibian Metamorphosis.—E. A. SPAUL ("Comparative Studies of Accelerated Amphibian Metamorphosis," *Brit. J. Exp. Biol.*, 1928, 5, 212–31, 4 text-figs.). The administration of active anterior pituitary lobe extracts in solution is not effective in producing precocious transformation of tadpoles. The rate of metamorphosis induced by injection of either thyroid or anterior pituitary depends on the concentration of the initial dose. Exposure of tadpoles to X-rays alters the susceptibility to factors accelerating metamorphosis. The effect increases with age. G. M. F.

Ovary of Mouse and X-Rays.—F. W. R. BRAMBELL, U. FIELDING, and A. S. PARKES ("Changes in the Ovary of the Mouse following Exposure to X-Rays. Part IV. The Corpus Luteum in the Sterilised Ovary and some Concluding Experiment," *Proc. Roy. Soc. B.*, 1928, 102, 385-96, 1 pl.). After X-ray sterilisation there is no new formation of oocytes. The degenerative changes in the corpora lutea start at the same age in the sterile as in the normal ovary. They proceed more slowly, and the old corpora lutea become practically permanent components of the sterile ovary. This is attributed to the absence of competition with maturing follicles and new corpora lutea. G. M. F.

Castration and the Size of Organs.—J. R. BAKER ("The Influence of Age at Castration on the Size of Various Organs," *Brit. J. Exp. Biol.*, 1928, 5, 187-95, 3 text-figs.). Male pigs were castrated at the ages of 50, 100 and 200 days; others were kept intact. All were killed at 300 days. The seminal vesicles, bulbo-urethrales and adrenals were smaller when castration is performed at 100 days than when it is performed at 200 days. There is little or no difference between castration at 50 or 100 days. In uncastrated pigs the seminal vesicles and bulbo-urethrales are much larger even than those of pigs castrated as late as 200 days. It is probable that some change occurs in these organs at about the age of 100 days, rendering them progressively more and more sensitive to the gonad hormone. The thyroid, pineal, and pituitary are not significantly affected by the time of castration. G. M. F.

INVERTEBRATA.

Mollusca.

A New Parasitic Gastropod.—S. HIRASE ("Sacculus okai, a New Parasitic Gastropod," *Annot. Zool. Japonenses, Tokyo*, 1927, 11, 115-26, 2 pls.). An aberrant gastropod parasitic in the test of tunicates *Ascidia prunum* and *Boltenia ovifera* from the north-western Pacific. In general appearance the specimens closely resembled *Ctenosculum hawaiiense* Heath, but in addition to many differences of internal structure this form has a pectini-branch instead of an aspidio-branch. A new genus *Sacculus* belonging to the Tænioglossa is proposed. G. M. F.

Self-Fertilisation in *Lymnæa Palustris*.—E. D. CRABB ("Self-Fertilisation in the Pond Snail *Lymnæa palustris*," *Trans. Am. Micr. Soc.*, 1928, 47, 82-9, 1 pl.). In isolated *Lymnæa palustris* the reproductive process is as follows: sperms and ova ripen together in the acini and sperms enter the ova as they pass through the acini and hermaphrodite duct. Two polar bodies which retain their chromatin are regularly extruded. Definite egg and sperm pronuclei are formed from chromosome vesicles. The first cleavage nucleus is formed by the fusion of the egg and sperm pronuclei. The first and second cleavage nucleus each contain twice as many chromosomes as the first polocyte, the egg nucleus following the first maturation division or the equatorial plate of the second maturation division. It is concluded that *Lymnæa palustris* reproduces by self-fertilisation when reared in strict isolation, and that the sperm which fertilises the ovum enters it before either the sperm or the ovum has passed out of the hermaphrodite apparatus. G. M. F.

Molluscan Fauna of Corsica.—L. GERMAIN ("Les mollusques terrestres et fluviatiles de la Corse," *Bull. Soc. Sci. Hist. et Nat. Corse*, 1925-26, 45, 133-47). The malacological fauna of Corsica and Sardinia is a Mediterranean one with certain remarkable peculiarities. Although it lacks a number of the species characteristic

of Provence and reveals no analogies with that of Catalán and the Balearic Islands, entire groups of Eastern origin, others with their affinities in Liguria and Sicily, and some fluviatile African species, are found. *Biological Abstracts.*

Arthropoda.

Arachnida.

Development of *Latrodectus*.—P. B. SIVICKIS and R. S. FILOTTO ("Observations on Development of the Spider *Latrodectus Nasseltii* Thorell," *Trans. Am. Micr. Soc.*, 1928, 47, 11-28, 3 pls.). The life-cycle in *Latrodectus Nasseltii* is completed in about 60 days. Between 100 and 200 eggs are laid at one time. Observations on development of the living egg, and study of prepared sections of various stages of the embryo, show that the eggs have a distinct polarity which can be traced to the ovogonial stages in ovogenesis. The early development, of the embryo is limited to the animal pole. The blastoderm, the ventral plate, and the structures associated with them in earlier stages of development, are restricted to the animal pole also. The primitive cumulus marks the anterior region of the ventral plate and gives rise to the organs associated with the anterior end of the body. The caudal thickening marks the posterior region of the body. Reversion and the later development are very similar to that of most other spiders.

G. M. F.

Arthropoda.

Crustacea.

The Plymouth Brachyura.—M. V. LEBOUR ("Studies on the Plymouth Brachyura. II. The Larval Stages of *Ebalia* and *Pinnotheres*," *J. Marine Biol. Assn.*, 1928, 15, 109-24, 2 pls. and 1 text-fig.). There are three species of *Ebalia* at Plymouth—*E. tuberosa* (Pennant), *E. Cranchii* Leach, and *E. tumefacta* (Montagu). Of these the first is much the commonest. Though *Ebalia* and *Pinnotheres* are placed by systematists in widely different groups, they resemble each other closely in many details of their larval stages, as in the possession of a rudimentary antenna which is merely a stump. In both *Ebalia* and *Pinnotheridae* there is a tendency to reduce the forks of the telson so that it becomes a more or less flat plate with the long spines shortened. In both, the abdominal segments are less than the normal number in the later stages.

G. M. F.

The Life-History of *Thysanocessa Raschii*.—R. MACDONALD (*J. Marine Biol. Assn.*, 1928, 15, 57-79, 7 pls.). The material was obtained from the Firth of Clyde. The "eggs" vary in size, the diameter of the outer shell measuring 0.40 to 0.60 mm., while the egg proper measures 0.35 mm. in the unsegmented to 0.38 mm. in the segmented and young embryo stages. The naupliar forms conform closely to those of *T. inermis*. The metanauplius is characteristically slender. The first calyptopsis stage arises from the metanauplius. There are three calyptosis stages, all of which are perfectly transparent apart from two pairs of red chromatophores which appear on the telson. The furcilia and cyrtopia stages are also described at length.

G. M. F.

***Anelasma Squalicola*.**—W. E. FROST ("The Nauplius Larva of *Anelasma squalicola* (Loven)," *J. Marine Biol. Assn.*, 1928, 15, 125-28, 4 text-figs.). The present description is limited to the external features only. The greater part of the body is covered by a dorsal segmented carapace which is produced at its antero-lateral extremities into two processes. No trace could be found of the

nauplius eye. The main part of the body passes posteriorly into a five-segmented spine, the chitinous covering of which is a continuation of the carapace.

G. M. F.

Loimia medusa Sav.—D. P. WILSON ("The Post-Larval Development of *Loimia medusa* Sav.," *J. Marine Biol. Assn.*, 1928, 15, 129-50, 2 pls. and 7 text-figs.). The larva of a Terebellid which is very common in plankton from the Plymouth district during spring was reared and proved to be the young of *Loimia medusa* Sav. The larva is characterised by its very large gelatinous tube. The development of the external structures is described from a stage in which the first tentacle was just appearing to a juvenile stage in which all the main characters of the adult had been assumed. The development of the bristles and uncini is dealt with; evidence of the suppression of a pair of larval bristle-bundles in *Loimia* is indicated. The building of the first sandy tube on the bottom is described.

G. M. F.

Gammarus under Laboratory Conditions.—E. W. SEXTON ("On the Rearing and Breeding of *Gammarus* in Laboratory Conditions," *J. Marine Biol. Assn.*, 1928, 15, 33-55, 1 text-fig.). The animals are kept in finger-bowls half full of water, so as to provide sufficient oxygen for the animals' needs. The water is made up of one part salt water to four parts fresh water. No regular air circulation is needed, but an occasional pipetting of the water with a sterilised pipette is beneficial. The food consists of rotted leaves, preferably elm leaves.

G. M. F.

Arthropoda.

Insecta.

Australian Hesperiidæ.—G. A. WATERHOUSE ("Australian Hesperiidæ. Pt. I," *Proc. Linn. Soc., New South Wales*, 1927, 52, Pt. 3, No. 212, 275-83, 1 pl.). Since "The Butterflies of Australia" was published in 1914, further collecting has resulted in records from many new localities, together with several new forms of "skippers." The more important of these are given in the present paper, and include the following:—*S.-F. Trapezitine*; *Trapezites eliena* Hew.; *T. eliena eliena* Hew.; *T. eliena monocycla* Lower; *T. iacchoides* Waterh.; *T. phigalioides* Waterh.; *Signeta tynbophora* M. and L.; *Anisynta sphenosema* M. and L.; *A. tillyardi* Waterh. and Lyell; *A. tasmanica* Misk.; *Toxidia malindeva* Low; *T. crypsigramma* M. and L.; *T. sexguttata* H.-S.; *Motasingha monticola* Olliff.; *M. dominula* Plötz.; *Hesperilla andersoni* Kirby; *H. idothea* Misk.; *H. donnyssa* Hew.; *H. donnyssa donnyssa* Hewitson; *H. donnyssa flavescens* n. s.sp.; *H. donnyssa aurantia* n. s.sp.; *H. donnyssa galena* n. s.sp.; *H. chrysotricha* Mey. and Low.; *H. chry. chrysotricha* Mey. and Low.; *H. chry. leucospila* n. s.sp.; *H. chry. plebeia* n. s.sp.; *H. crypsargyra* Mey.; *H. crypsargyra crypsargyra* Meyr.; *H. crypsargyra hopsoni* n. s.sp.

M. E. M.

Australian Coleoptera.—ARTHUR M. LEA ("Descriptions of New Species of Australian Coleoptera," *Proc. Linn. Soc., New South Wales*, 1927, 52, Pt. 3, No. 212, 354-77). The paper describes the following new species, all of which belong to the family *Curculionidæ*:—*Coptorhynchus albivarius* n. sp.; *C. ocularis* n. sp.; *C. trivittatus* n. sp.; *Rhinoscapa interrupta* n. sp.; *Mandalotus pyrifera* Lea; *M. mirabilis* Lea; *M. sternocerus* n. sp.; *M. arnicoxis* n. sp.; *Baris bituberculata* n. sp.; *B. caelestis* n. sp.; *B. pulchriparva* n. sp.; *B. hoplocnemis* n. sp.; *B. orthodoza* n. sp.; *B. parvonigra* n. sp.; *B. setistriata* n. sp.; *B. trisinuata* n. sp.; *B. melanostetha* n. sp.; *B. illepidia* n. sp.; *B. melanochoa* n. sp.; *B. vulnerata* n. sp.; *B. episternalis* n. sp.; *B. setipennis* n. sp.; *B. cyaneotincta* n. sp.; *B. niveodispersa*

n. sp.; *B. præmorsa* n. sp.; *B. latericollis* n. sp.; *B. dilatatifrons* n. sp.; *B. pulchripennis* n. sp.; *B. angophoræ* Lea; *B. transversicollis* Lea; *B. sororia* Lea; *B. microscopica* Lea; *B. geraldtonensis*, new name (syn. *B. oblonga* Lea); *B. cairnsensis*, new name (syn. *B. glabra* Lea); *B. barronensis*, new name (syn. *B. ebenina*, Lea); *Ipsichora tibialis* n. sp.; *I. binaculibasis* n. sp.; *I. desiderabilis* Lea; *Solenobaris cryptorhynchoides* n. sp.; *S. edentata* Lea; *Lepidobaris* n. gen.; *L. metasternalis* n. sp.; *Apinocis* n. gen.; *A. variipennis* n. sp.; *Pentarthrum orthodoxum* n. sp.; *P. foveiventre* n. sp.; *P. foveiceps* n. sp.; *P. interoculare* n. sp.; *P. strigicolle* n. sp.; *Notiosomus insularis* n. sp.; *Isotrogus irregularis* n. sp. The recorded habitats of these species are also given. M. E. M.

New Wasp from Paraguay.—ROLAND E. TURNER ("On a New Thynnid Wasp from Paraguay," *Entomologische Mitteilungen*, 1927, 16, No. 6, 449). The author describes a new species of Thynnid wasp, *Spilothynnus horni* n. sp., collected by R. Meyer from Villa Rica, Paraguay. The type and co-type are in the Deutsches Entomologisches Museum, while another co-type is in the British Museum of Natural History. M. E. M.

New Australian and African Diptera.—C. H. CURRAN ("Some New Australasian and African Diptera of the Families Muscidae and Tachinidae (Dipt.)," *Entomologische Mitteilungen*, 1927, 16, No. 6, 438-48). The author gives descriptions of the following genera and species:—*Proscissio* Hutton; *P. princeps* n. sp.; *P. montana* Hutton; *P. cana* Hutton; *P. modica* Hutton; *Peremptor* Hutton; *P. pavida* Hutton; *P. vittata* n. sp.; *Plagiomyia*, new genus; *P. turbidum* Hutton; *Calcager* Hutton; *C. apertum* Hutton; *Calcageria* new genus; *C. incidens* n. sp.; *Palia*, new genus; *P. aureocauda* n. sp.; *Paliana* new genus; *P. basalis* n. sp.; *P. intensa* n. sp.; *Amplipila*, new genus; *A. versicolor* n. sp.; *Sturmia anaphe* n. sp. Keys for the identification of some of the species are also included. M. E. M.

Australian Mosquitoes.—I. M. MACKERRAS ("Notes on Australian Mosquitoes (Diptera, Culicidae). Part II. The Zoogeography of the Sub-Genus *Ochlerotatus*, with Notes on the Species," *Proc. Linn. Soc. of N.S.W.*, 1927, 52, Pt. 3, No. 212, 284-98). Edwards in 1924 recognised 17 valid species of the sub-genus *Ochlerotatus* (*Aedes*) from the mainland of Tasmania, later (1926) raising the number to 20. In the present paper Mackerras adds a further new species, while he reduces two names to synonymy, bringing the total down to 19. The total representation of the sub-genus in the Australian region is 22 species. Two distinct groups are to be recognised: A with Holarctic affinities, and B with Neotropical affinities. It is with these two groups and the explanation of the apparent anomalies of their distribution that the author is concerned. There is definite evidence for the belief that Australia was colonised from South America. This evidence is greatly strengthened in the case of Group A by the local distribution in Eastern Australia, a line of investigation which also clearly indicates that the two groups followed different routes and entered this country from different directions. In Group A nine species are strictly "Antarctic" in distribution, i.e. dominant in Tasmania, while those occurring also in New South Wales are restricted to the highlands of the Divide, with extensions to the coast in spring. It must be remembered, however, that the limitations of different faunal elements to particular environments, though very striking, is not absolute. Group B presents a different problem. Its Neotropical affinities would suggest an antipodal origin, but the local distribution is unequivocally against Antarctic radiation. The male hypopygium

presents valuable group characters which are, in all the Australian species, sufficiently well marked to afford easy and rapid determination. The author gives a key to the Australian species of *Ochlerotatus*, *Banksinella*, and *Aedimophus* (females), and includes a description of these species with their recorded distribution.

M. E. M.

New Indian Miridæ (Capsidæ).—E. BALLARD ("Some New Indian Miridæ (Capsidæ)," *Mem. Dept. Agri. in India*, 1927, 10, No. 4, Ento. Series, 61-8, 7 pls.). The author gives a description of the following new species:—Sub-Family *Mirinae*, Div. *Capsaria* Reut., *Deræocoris maculatus* n. sp.; *D. indicus* n. sp.; *D. aphidicidus* n. sp.; *D. dissimilis* n. sp.; *Stechus fletcheri* n. sp.; *Megacelum esmedoræ* n. ps.; *M. horni* Poppius; *Hyalopeplus krishna* n. sp.; *Pæciloscytus rugulus* n. sp. *P. aureus* n. sp.; Sub-Family *Macrolophinae*, Div. *Cremnocephalaria*, *Nicostratus mononoriiformis* n. sp.; *Sohenus uvarovi* n. sp.; Sub-Family *Macrolophinae*, Div. *Macrolopharia* *Cyrtopeltis* (*Gallobelicus*, Dist.) *cruentatus* n. sp.; *Cyrtopeltis* (*Gallobelicus*, Dist.) *cæsar* n. sp.; *Armachanus pusæ* n. sp.

M. E. M.

Indian Gall Midges.—E. P. FELT ("Four New Indian Gall Midges," *Mem. Dept. Agri. in India*, 1927, 10, Nos. 1 and 2, Ento. Series, 1-4). The descriptions are based upon a small collection of gall midges received from Rao Sahib Y. Ramachandra Rao, Acting Government Entomologist of Coimbatore, South India, under date of March 17th, 1926. The rearings add materially to our knowledge of the biology of the Indian species. The following species are described: *Dasyneura mangiferæ* n. sp.; *Schizobremia malabarensis* n. sp.; *Lopesiella polliniae* n. sp.; *Cecidomyia malabarensis* n. sp.

M. E. M.

The Citrus Psylla.—MOHAMMAD AFZAL HUSAIN and DINA NATH ("The Citrus Psylla (*Diaphorina citri* Kuw.) Psyllidæ: Homoptera," *Mem. Dept. Agri. in India*, 1927, 10, Nos. 1 and 2, 5-27, Ento. Series, 3 pls., 3 text-figs.). Of the insect pests of Citrus in India, *Diaphorina citri* Kuw., commonly known as the "Citrus Psylla," is of the greatest importance. It is present all over the country, and has been so abundant in many localities as to call forth special attention. In certain tracts in the Punjab it has been responsible for very serious losses. In one particular instance a citrus orchard which was normally leased for Rs. 2000 per season yielded no more than Rs. 100 after an attack of this pest lasting for a couple of years. It is not an uncommon sight to see once valuable orchards reduced to unproductive plantations of dried skeletons of trees, primarily through the ravages of this insect. The pest has been under observation for the last six years by the authors both in the laboratory and under orchard conditions, and details of its structure, life-history, bionomics and control are presented in this paper.

M. E. M.

Australian Asilidæ.—G. H. HARDY ("Further Notes on a New Classification of Australian Robber-Flies (*Diptera-Asilidæ*)," *Proc. Linn. Soc. New South Wales*, 1927, 52, Pt. 3, No. 212, 387-98.) The author proposes a new classification of Australian *Asilidæ*. In 1921 he revised the characters of various genera of the Australian *Asilidæ*, and again in two papers of 1926 reconsidered some of these. These three papers marked a stage in a search for an adequate classification, which is further advanced in the present paper, wherein the family is treated as a whole. Three proposed tribes have, in the earlier papers, already been diagnosed, and these are maintained, though a different conception is given to some of them, and four more tribes are added, two of which have previously been mentioned. An improvement will be found in the incorporation of part of the old sub-family

Laphrinæ with the *Saropogonini*, two genera being thus transposed, whilst the *Cerdistus-Neotanus* complex is more adequately isolated, though very little altered in effect, the genus *Stilpnogaster* being now excluded from that complex. Three sub-families only are recognised, the tribe *Laphrini* being too intimately connected with *Brachyrrhopala* and *Phellus* to permit of its isolation except perhaps under quite a different conception to that understood by the old sub-family *Laphrinæ*. *Saropogonini*, judging from Australian collections, seems to warrant sub-family rank, but this is not followed in the present paper. The sub-family *Asilinae* is now divisible into two tribes, *Ommatiini* and *Asilini*, whilst the typical genus of the latter, *Asilus*, is excluded from the Australian fauna. The author gives a key from which the tribes are recognisable, and discusses the hypothetical genealogical relationships between these tribes. The remainder of the paper is devoted to a discussion of the tribes and the related genera.

M. E. M.

Stegomyia and Yellow Fever.—M. J. LEGENDRE ("Races de *Stegomyia fasciata* et fièvre jaune," *Compt. Rend. des Séances de l'Acad. des Sci.*, 1927, 185, 1224–26). The author advances the suggestion that *Stegomyia fasciata* (*Aedes argenteus*) is separable into two distinct races—a large race which he terms the *africano-américaine*, and a smaller race termed the *océano-indienne*. The suggestion is based on observations made by the author that it is only the former race which transmits yellow fever, though both races are thought to be the vectors of dengue fever. The author draws attention to the well recognised fact that the geographical distribution of yellow fever does not in many parts of the world coincide with the wider distribution of *Aedes argenteus*, that in spite of maritime traffic from endemic centres of yellow fever to other parts of the world where *Aedes argenteus* flourishes, epidemics of the disease have failed to occur. He points to the fact that even from the days of sailing ships to the present time, vessels have passed from the hot-beds of yellow fever on the West Coast of Africa to destinations on the south-west and south-east of the continent, to Madagascar and the Mascarene Islands, yet all these places where *Aedes argenteus* occurs have, nevertheless, remained immune from yellow fever. Certain morphological variations in both the larvæ and adults are thought to represent the particular characters of the two races, and attention is called to the phenomenon that not all the species of *Anopheles* are capable of acting as the vectors of malaria. The author therefore considers that the fears often expressed that yellow fever may be introduced accidentally to regions where *Aedes argenteus* exists are not always justified if in such regions the non-vector race only is present.

M. E. M.

Melanism in Insects and its Inheritance.—J. W. HESLOP HARRISON ("A Further Induction of Melanism in a Lepidopterous Insect *Selenia bilunaria* Esp. and its Inheritance," *Proc. Roy. Soc. B.*, 1928, 102, 338–47). By administering food containing manganese chloride to a strain of *Selenia bilunaria* known by the use of adequate controls to be free from heritable melanism, melanic insects have been developed. The melanism has been proved to be inherited as a Mendelian recessive. Certain mosaics were obtained in the critical treated brood, but these, from experimental tests, were seen to represent cases of induction restricted to limited areas in the soma, the germ plasma being apparently unaffected. The effect is not of the Lamarckian type, but rather illustrates a new evolutionary principle that heritable variations may be induced by means of the food supplied. Although other explanations are not absolutely excluded, the experiments indicate that the metal is the active agent in bringing about the observed effect.

G. M. F.

The Production of Silk by Flies.—H. ELTRINGHAM ("On the Production of Silk by Species of the Genus *Hilara* Meig (Diptera), with an Appendix on the Habits of the Species by A. H. HAMM," *Proc. Roy. Soc. B.*, 1928, **102**, 327–38, 1 pl., 6 text-figs.). The silk glands were found to consist of numerous large pear-shaped cells in the enlarged basal joints of the fore-tarsi. The tubular ducts from the cells end at the chitinous exterior, principally on the narrow edge of the tarsal joint at the base of a specialised spine. G. M. F.

Induced Pigment Changes in the Pupæ of Butterflies.—J. W. HESLOP HARRISON ("Induced Changes in the Pupæ of the Butterfly *Pieris napi* L. and Their Inheritance," *Proc. Roy. Soc. B.*, 1928, **102**, 347–53). The pupæ of *Pieris napi*, when developed from larvæ exposed at the critical time to lights of different colours, are influenced in their pigmentation like those of their congeners, *Pieris brassicae* and *P. rapæ*. As Dürken and Brecher found in the case of *P. brassicae*, the green pupal colour acquired under the influence of orange light is inherited. G. M. F.

Starvation and Longevity in *Drosophila*.—S. KOPEC ("On the Influence of Intermittent Starvation on the Longevity of the Imaginal Stage of *Drosophila melanogaster*," *Brit. J. Exp. Biol.*, 1928, **5**, 204–11). The longevity of the imago stage of *Drosophila* is decreased by starvation, although flies which were starved for six out of the twenty-four hours, and which were not deprived of water, lived as long as the controls. The longevity of flies increased in inverse proportion to the intensity of starvation. G. M. F.

Structural Colours in Insects.—C. W. MASON ("Structural Colors in Insects," *Journ. Phys. Chem.*, 1926, **30**, Pt. 1, 383–95; 1927, **31**, Pt. 2, 321–54; 1927, **31**, Pt. 3, 31, 1856–72). In the literature on insect colours one finds a very striking lack of agreement on many points; the nature of various colours thought to be due to structural conditions has been the subject of a great many conflicting papers. There has been an unfortunate tendency to assume that all the insect colours are to be explained on the same basis. Actually to determine the relationship of the structural features to the colour phenomena observed in any given case requires more than a cursory inspection, particularly since pigmental and structural colours are combined in many instances and mutually influence the appearance observed. In the paper under review the author presents information which is of great interest, not only to entomologists, but to all scientific investigators. The careful and extensive work accomplished adds considerably to our knowledge of colour phenomena. In Part 1 the author gives methods by which the distinction between structural and pigment colours can be made, and discusses the white, lustrous white, and non-porous white found in insects. An account of the influence of structure on coloration follows with an explanation of Tyndall blues in insects. The author's conclusions in Part 1 are:—That all whites of insects are structural; pearly and metallic lustres are due to superposed transparent parallel laminæ; that Tyndall blue occurs only in a few insects, while blue pigments do not appear to be present in insects; and that structural conditions may modify the appearance of pigment colours very markedly. Part 2 of this paper discusses Iridescent Colours, Iridescent Wing Membranes, the Nature of Iridescent Colouring of Wing Membranes, Iridescent Scales, *Urania* and Similar Scales, *Morpho* and Similar Scales, Beetle Scales, Iridescent Scales compared with that of Thin Films, and the Applications of the Thin-Film Theory to Type Specimens, the conclusions reached being that

(1) iridescent wing membranes owe their colour to multiple thin films separated by material of slightly different refractive index; (2) iridescent scales are of three main types, each of which owes its colour to multiple thin films separated by air; (3) in scales of the *Urania* type the colour-producing lamellæ are parallel to the plane of the scale, and may be overlaid by a ribbed or meshed structure; (4) in scales of the *Morpho* type the colour-producing lamellæ are in the vanes on the upper surface of the scale, and are inclined towards the root of the scale; (5) in scales of the *Entimus* type the lamellæ are enclosed by a cuticle, and are tilted in different directions in sharply defined areas; (6) the fine striations common on insect scales are not related to the iridescence visible under ordinary conditions; (7) selective reflection (surface colour) is not exhibited by iridescent insect scales. Part 3 is devoted to the consideration of Iridescent Integuments, "Metallic" Integuments, the Nature of Iridescent Colouring of "Metallic" Integuments, "Enamelled" Iridescent Integuments and their Nature, and, finally, the Diffraction Iridescence. The author's conclusions to this part are:— (1) "Metallic" iridescent insect integuments owe their colour phenomena to a thin laminated layer at or just beneath the surface, which acts as a multiple thin film; (2) the colour-producing structure may be much thicker, with many more laminæ, as in *Plusiotis gloriosa*, where it is embossed rather than smooth; (3) "enamelled" iridescent integuments owe their colour phenomena to a thick multiple-film layer, the properties of which are modified by the closely spaced minute rods which perforate it; (4) diffraction iridescence has been identified in *Serica*, but does not occur in "metallic" or "enamelled" integuments (the properties and criteria for identification of the above types of iridescence are discussed in detail); (6) selective reflection (surface colour) is not exhibited by iridescent insect integuments.

M. E. M.

New Species of Insects.—R. P. LONGINUS NAVÁS ("Insecta Nova, Series XII," *Memorie Della Pont. Accademia Delle Scienze—I Nuovi Lincei*, 10, Serie II, 1–10, 4 text-figs.). Descriptions in Latin are given of the following insects:—*Neuroptera*, Fam. *Ascalaphidæ*, *Haploglenius bolivianus*, sp. nov. from Bolivia—Buenavista, Departamento de Santa Cruz; *Ululodes Apollinaris*, sp. nov. from Colombia—Villavicencio, 1925; Fam. *Myrmeleonidæ*, *Guipa*, gen. nov., *Guipa columbiana*, sp. nov. from Colombia—Villavicencio, 1925; Fam. *Chrysopidæ*: *Chrysopa lanata* Banks var. *lineata*, nov. from Colombia—Choachi, 1915; *Chrysopa Uribei*, sp. nov. from Colombia—Cundinamarca; *Chrysopa tarsalis*, sp. nov. from Africa—Orange Free State; *Cintameva Firmini*, sp. nov. from Cuba—Habana, 1925; *Leucochrysa claveria*, sp. nov. from Colombia—San Antonio de Tena, 1926; *Rhaphidioptera*, Fam. *Rhapididæ*, *Puncha ilalica*, sp. nov. from Italy—Calabria.

M. E. M.

New Oriental Insects.—R. P. LONGINUS NAVÁS ("Insecta Orientalis, Series V," *Memorie Della Pont. Accademia Delle Scienze—I Nuovi Lincei*, 10, Serie II, 11–26, 7 text-figs.). Descriptions in Latin are given of the following new species:—*Neuroptera*, Fam. *Ascalaphidæ*, *Hybris stenoptera*, sp. nov. from China—Lienping; Fam. *Myrmeleonidæ*, *Palpares validus*, sp. nov. from Asia—Kabul, Afghanistan; *Segra misera*, sp. nov. from Ceylon; *Euroleon sibiricus*, sp. nov. from Asia—Baikal; *Neuroleon syrus*, sp. nov. from Syria—Beit Meri; *Pignatellus baicalicus*, sp. nov. from Asia—Turan, Baikal; *Deutoleon*, gen. nov., *Deutoleon turnaicus*, sp. nov. from Asia—Turan, Baikal; *Deutoleon lineatus*, from China; Fam. *Chrysopidæ*, *Chrysopa vulgaris* Schn. var. *radialis* Nav., from China; *Chrysopa Delmasi*, sp. nov. from Oceania—Marquesas Isles; *Chrysopa*

Delmasi Nav. var. *densata*, nov. from Formosa; *Cintaneva splendida* Weele, Formosa—Seira; Fam. *Hemerobiidae*, *Hemerobius inversus*, sp. nov. Philippine Islands—Luzón; *Megalomus axillatus*, sp. nov. from Philippine Islands—St. Thomás; *Megaloptera*, Fam. *Chaulioididae*, *Parachaulioides buschi* Nav., China—Lienping; *Neuromus exterior*, sp. nov. from Tonkin; Fam. *Sialidae*, *Sialis sibirica* MacLachl. Usuri, Siberia; *Mecoptera*, Fam. *Panorpidae*, *Neopanorpa formosana* Nav., China; *Psocoptera*, Fam. *Thyrsopteridae*, *Mindaus*, gen. nov., *Mindaus irretitus*, sp. nov. from Philippine Islands—Momungan; *Plecoptera*, Fam. *Pteronarcidae*, *Pteronarcys sachalina* Klap, Turan, Baikal. M. E. M.

Neuroptera from China.—R. P. LONGINUS NAVÁS ("Névroptères de la Chine," *Arkiv. för Zoologi, Stockholm*, 1927, 19a, Häfte 2, No. 18, 1-5). The *Neuroptera* enumerated and described were sent to the author by Prof. Sjöstedt. All are interesting, and some are species new to science. The new species are:—Fam. *Ascalaphides*, *Idricerus Sjöstedti* sp. nov.; *Hybris Kolthoffi* sp. nov.; Fam. *Chrysopides*, *Chrysopa Kolthoffi* sp. nov., *Chrysopa Kolthoffi* Nav. var. *rubescens* nov., Fam. *Mantispides*, *Mantispylla deliciosa* sp. nov. M. E. M.

Tipulidæ from Kamtchatka.—C. P. ALEXANDER ("Entomologische Ergebnisse der Swedischen Kamtchatka Expedition 1920-2, 12. The Tipulidæ," *Arkiv för Zoologi, Stockholm*, 1927, 19a, Häfte 2, No. 9, 1-10, 5 text-figs.). The itinerary, general ecological conditions, and summary of results of the Swedish Kamtchatka Expedition of 1920-2 have been discussed by Dr. Sjöstedt in the first part of these published papers. Through Dr. Sjöstedt and the collector of the material, René Malaise, the author has been enabled to study the crane-flies of the expedition. Types and representatives of all the species have been played in the Naturhistoriska Riksmuseet in Stockholm. As might be expected from its geographical location, the Tipulid fauna of Kamtchatka shows a distinctly Holarctic facies, several of the species showing scarcely any modification from European types, while still others are considered as representing valid races of European species. This northern Palearctic element is shown strongly in the genera *Limonia*, *Dicranomyia*, and *Dictenidia*. The species of *Limnophila*, on the other hand, seems to be the most closely related to Nearctic *L. platyphallus* Alexander, of which it is, at most, the vicarious representative in North-Eastern Asia. The very interesting Tipulid, *Tipula malaisei* sp. nov., herein described, belongs to a peculiar group of the genus (the *cineracea* group) that is confined to the region of Bering Straits. The only earlier paper which considers the crane-flies of Kamtchatka is a brief one by the author (*Journ. New York Ento. Soc.*, 1918, 26, 66-75). Descriptions of a large number of species are provided in the present paper. M. E. M.

Ant Mounds.—E. A. ANDREWS ("Ant Mounds as to Temperature and Sunshine," *Journ. Morph. and Physiol.*, 1927, 44, No. 1, 1-20, 2 text-figs.). The ant *Formica exsectoides* F. makes mounds of earth two to three feet high, and this ton or more of earth is favourably shaped for absorbing heat and light from above. Evidence having been found that these mounds increase in sunny and dwindle away in shady localities, the authors have considered it of interest to inquire further as to the way in which the sun affects these mounds. Mounds of the ant *Formica exsectoides* are built with reference to the sunlight, and measurements of internal temperatures in the summer show that the upper parts of the conical mounds are warmer than the lower, that all parts are warmer than the earth outside, and that different faces have different temperatures. These inside temperatures are not constant, but vary from hour to hour and from day to day.

Prolonged rains in cloudy weather tend to reduce all parts to uniformity, approaching the low temperature of the surrounding earth. The internal temperatures are due to heat received from the sun. The mounds being fabricated with closed roofs and included air-chambers, the acquired internal temperatures tend to be conserved during the night. The ants seem to make use of the different internal temperatures, selecting at times certain portions of a mound for rearing the brood, which is known to be greatly dependent upon temperature conditions. In winter melting snow shows the reception of the greater heat by the south face, and in the summer some of the mounds have the greater internal temperature in the south parts. Some mounds show bilateral symmetry with the largest face to the south, unless some shading prevents the greater access of sunlight to the south face. Measurements of the rates of running of these ants show that the rates fall off with lower temperatures, so it is suggested that the small size of the north, as compared with the south part of bilateral mounds, may be due in part to direct effects of sunshine in speeding up the work of the ants upon the warmer surfaces of the mounds.

M. E. M.

Bees and Wasps of Essex.—CHARLES NICHOLSON ("Notes on the Solitary Bees and Wasps of Essex," *The Essex Naturalist*, 1927-28, 22, Pt. 2, 81-95). This paper concerns the "solitary" species only of the Aculeate section of the great order of insects known as *Hymenoptera*. The solitary bees and wasps of Britain are all winged in the perfect state, and the males are usually smaller and more slimly built than the females; but, on the other hand, they are more numerous and much more active. Where there is eccentricity of structure, such as an unusually large head, it is generally confined to the males, but the females often exhibit excess of coloration. The life-histories of these insects seem to be modelled on a broadly uniform plan. About 230 species of solitary bees and wasps—bees 212, wasps 18—have been recorded in the British Isles, and of these some 140 species have been found in Essex, comprising 62 p.c. of the bees and 78 p.c. of the wasps. These percentages are interesting when one realises that Essex is essentially a clay county, and most of the solitary wasps use clay for their nests, while the bees, on the whole, prefer the lighter soils, wherever these are to be found. The author gives a full account of the species under review, including notes on their bionomics and host plants and the parasitic nature of several species.

M. E. M.

Temperature Effects on *Drosophila Virilis*.—J. E. NADLER ("Effects of Temperature on Length of Vestigial Wing of *Drosophila virilis*," *Genetics*, 1926, 2, 584-9). While carrying on selection experiments with the vestigial wing form of *Drosophila ampelophila*, Roberts (1918) noted that during the summer months the length of the wing increased. He later placed some of the progeny in an incubator at about 28° and the rest at room temperature of about 22°. He concluded that the length of the vestigial wing increases with an increase in the temperature, and that the males are affected more by high temperature than are the females. The present paper records an attempt to ascertain whether low as well as high temperatures modify the wing length of *Drosophila*, and whether the change resembles that of a chemical reaction. It has been found in the case of homogeneous reactions that a rise of 10° in the temperature increases the rate of reaction two to four times, or, on the average, by 2.5 times, and the author mathematically and experimentally makes the following conclusions:—(1) The vestigial wing length of *Drosophila virilis* is modified by changes in temperature in the manner of chemical reaction. The temperature coefficient (Q_{10}) is approximately 1.98. (2) Low temperatures affect this character more than high temperatures. The temperature

coefficient for the range between 12–20° is approximately 2.44, while that between 20–30° is 1.15. (3) The changes in wing length due to temperature are not hereditary when the offspring are bred at room temperature. (4) There is thus need of maintaining a constant temperature during the study of the genetics of wing length of *Drosophila*.
M. E. M.

The Spreading and Penetration of Oils.—J. M. GINSBURG ("The Effect of Various Chemicals on the Spreading and Penetration of Oils in Different Mosquito Breeding Places," *Proc. of 14th Annual Meeting of N. Jersey Mosquito Exter. Assn.*, 1927, 1–10). Investigations were carried out with the purpose of improving the spreading power of fuel oil used for larvicidal purposes by the addition of certain chemicals. From the various chemicals tested, the tar acids having hydroxyl (OH) groups (such as phenols, cresols, xylenols), the monohydric alcohols, pine oil and turpentine, increased the spreading power of mineral oils. Cresols and xylenols proved more efficient than the other compounds. Results from laboratory and field tests have definitely shown that the addition of one gallon of crude cresol containing 95 p.c. cresylic acids to 100 gallons of fuel oil greatly increased the spreading and penetration on salt and fresh waters covered with dead organic matter and vegetation. Laboratory measurements have shown that a given quantity of fuel oil containing 1 p.c. crude cresol covered one and a half times as much water surface as did an equal quantity of the same oil without this chemical. The duration of the oil film was also appreciably increased by this treatment, especially on sewage beds.
M. E. M.

Mosquito Control in New South Wales.—B. BERTRAM ("Mosquito Control in the Municipality of Lane Cove, New South Wales," *Proc. Linn. Soc. of N.S.W.*, 1927, 52, Pt. 4, No. 213, 561–9). The work was undertaken, not because of any serious danger from mosquito-borne disease, but because mosquitoes were sufficiently abundant to be a public nuisance. A survey was therefore carried out in 1925, and a report with recommendations was presented to the Lane Cove Council, which afterwards authorised a small expenditure enabling control measures to be undertaken in an area of limited extent. The results were so satisfactory that adequate provision is now made for maintaining this work and extending it to other parts of the municipality. The mosquito survey disclosed the presence of 10 species of mosquitoes, including one Anopheline, *Anopheles annulipes* Walker. Of these 10 species, *Culex fatigans* was considered the only species requiring serious attention. The problem was to deal with *C. fatigans* breeding in natural collections of water such as creeks and drainage easements rather than in artificial collections of water. The area under control was four square miles in extent. Control consisted in the adoption of the usual methods—oiling, channelling, clearing, etc.—and the completed work was adequately maintained in satisfactory operation by a single man. As a result of laboratory experiments, the authors advocated the use of an anti-larval oil composed of three parts unrefined kerosene to one part of tar-oil, which was found to act well.
M. E. M.

Australian Diptera.—J. R. MALLOCK ("Notes on Australian Diptera No. XIII," *Proc. Linn. Soc. of N.S.W.*, 1927, 52, Pt. 4, No. 213, 399–446). In this paper the author presents descriptions of a number of species sent to him by Mr. A. L. Tonnoir, mostly from Tasmania, the type specimens of which are to be deposited in the Cawthron Institute, New Zealand. Descriptions of a large number of species are provided, many of the species being new to science. The species belong to the families *Sapromyzidae*, *Agromyzidae*, *Chloropidae*, and *Asteiidae*.
M. E. M.

Australian and Exotic Sarcophagidæ.—G. H. HARDY ("Notes on Australian and Exotic Sarcophagid Flies," *Proc. Linn. Soc. of N.S.W.*, 1927, 52, Pt. 4, No. 213, 447–59, 11 text-figs.). Taxonomic studies of *Sarcophagidæ*, under taken since the publication in 1923 of a revision of the Australian Diptera belonging to the genus *Sarcophaga*, by Prof. T. Harvey Johnston and the author, were pursued with a view to ascertaining the relationship between Australian species and those examined or that had been described from other parts of the world. The accumulation of odd notes so far compiled will prove, the author believes, of considerable interest and perhaps help towards establishing a satisfactory method of arranging the unwieldy genus *Sarcophaga* of groups of naturally allied species. The idea of grouping Sarcophagids on the genital characters of the male, which has been initiated by various authors, is extended and developed in the present paper. A method of preparing and mounting the genitalia is described, and the authors give descriptions of the genitalia of nine species. M. E. M.

Genitalia of the Micropterygoidea.—A. PHILPOTT ("Notes on the Female Genitalia in the Micropterygoidea," *Trans. Ento. Soc. of Lond.*, 1927, 75, Pt. 2, 319–23, pl. 27). Although a good deal of work has been done on the male genitalia of the *Micropterygoidea*, comparatively little attention has been paid to the generative organs of the female. In view of this, the writer has thought it worth while to put together his available notes on the female genitalia of the *Micropterygoidea* and *Eriocraniidæ*. Of these the following genera are dealt with:—*Eriocraniidæ*: *Eriocrania*, *Mnemonica*; *Micropterygoidea*: *Sabatinca*, *Epimartyria*, *Micropteryx*. M. E. M.

An Error of Metamorphosis.—E. A. COCKAYNE ("An Error of Metamorphosis, Hysterotely, in a Lepidopterous Pupa, with a Discussion on Prothetely and Hysterotely," *Trans. Ento. Soc. of Lond.*, 1927, 75, Pt. 2, 297–305, 1 text-fig.). The term hysterotely has been applied to cases in which the larval head has been retained in the pupa or imago, but this is merely due to an incomplete moult. If used at all, it should be reserved for the true errors of metamorphosis, in which larval characters appear in the pupa or imago or pupal characters appear in the imago. Examples of this abnormality form a more heterogeneous group than those collected under prothetely. Conversely, the term prothetely is applied to cases in which the larvæ or pupæ exhibit certain characters of the imago, such as wings, compound eyes, imaginal legs, pectinated antennæ, etc., or the larvæ exhibit pupal characters. The pupa which is the subject of this paper was collected by Mr. K. G. Blair under the fallen bark of a birch trunk on Stanmore Common, Middlesex. The pupa is that of a Microlepidopteron. Its general aspect suggests that it is that of a Teneid, but a more exact identification is impossible. The head shows both larval and pupal characters. The antennæ are pupal, though not as fully developed as in a normal pupa. The position of the ocelli is different from that found in the larval skin, for the cast skin shows six ocelli, five in a semi-circle facing anteriorly and the sixth lying alone posteriorly. The jaws are longer and narrower than those of the larval head and more sharply toothed, while several other larval and pupal characters are defined. The pupa was alive when first found, but died soon afterwards. The author discusses the theories which have been advanced to account for these errors of metamorphosis. Von Lengerken considers that it represents a pre-nymphal stage. Bauer thinks that mechanical injury may bring about accelerated development of the imaginal discs. Dewitz suggests that there is an oxydase produced gradually during development specific for every set of organs, and that if a particular oxydase is produced in too great

a quantity, the organs it stimulates develop prematurely. Strickland and Wheeler have found that insects parasitised by *Mermis* have the development of the imaginal discs inhibited. Many other theories are discussed, and for these the original paper should be consulted.

M. E. M.

New Aquatic Heteroptera.—TEISO ESAKI and W. E. CHINA ("A New Family of Aquatic Heteroptera," *Trans. Ento. Soc. of Lond.*, 1927, 75, Pt. 2, 279-95). The subjects of this study are two new genera of water-bugs, *Idiocoris* nov. and *Paskia* nov., which were collected during the recent British Museum Expedition to Tanganyika. These insects throw considerable light on the relationship of the genus *Helotrephes* Stal., and it is now evident that a new family, *Helotrephidae*, must be erected to hold the three genera. The authors conclude that *Helotrephes*, *Idiocoris* and *Paskia* form a natural group characterised by the fusion of the head with the pronotum, by the strongly asymmetrical male genital segments, and by the segmentation of the tarsi, which is 1-1-2 respectively, and propose to call this group *Cephalonotera* series nov., the phylogeny of the group being discussed in a subsequent part of the paper. The family *Helotrephidae* nov. is subdivided into two sub-families, *Helotrephinae* nov. and *Idiocorinae*, nov. respectively, the characters of which are defined. The new species described are *Idiocoris lithophilus* sp. nov. and *Paskia minutissima* sp. nov. Among some notes on the ecology and the biology of the *Idiocorinae* the authors state that the two species were collected under small stones in the surf-zone of Lake Tanganyika at the end of the dry season, and were found in the company of larvæ of various *Diptera*, *Trichoptera*, and *Turbellaria*. From the fact that the spiracles do not open externally, and the absence of abundant hairy pubescence on the under-surface of the body, it is thought probable that these water-bugs live continually on the under-surface of submerged stones, breathing oxygen dissolved in the water, and that, from the sedentary habits of these insects, they prey only upon inactive animals. It is reasonable to assume that *Turbellaria* form at least part of the diet of the *Idiocorid* species.

M. E. M.

Objections to the Mimicry Theory.—R. A. FISHER ("On Some Objections to the Mimicry Theory, Statistical and Genetic," *Trans. Ento. Soc. of Lond.*, 1927, 75, Pt. 2, pp. 269-78). The great statistical interest of all applications of the selection theory, of which mimicry is certainly one, makes the validity of the latter a matter of importance even beyond the limits of the biological sciences. The author is of opinion that it appears to be probable that disputed points which have arisen in discussions of mimicry should, in so far as they are of a purely statistical nature, be capable now of a definite and final decision. His conclusions are as follows: The contentions of Marshall that statistical reasons preclude that action of selection from favouring the modification of a more numerous species in the direction of closer resemblance to a similar but less numerous species, is without valid foundation. The contention of Punnett that mimicry rings contain more than one palatable mimic, much modified from its primitive appearance, must have arisen by discontinuous saltation, depends wholly on the validity of Marshall's argument. The Mendelian behaviour of the different forms of a polymorphic species does not prove that these forms arose by single saltations. The stability of the gene-ratios of factors controlling polymorphism implies a selective action, reproductive or other, influenced by the frequency-ratio of different forms. Any factor causing visible differences, and possessing a ratio of stable equilibrium, will provide a potential dimorphism capable of evolutionary development by the selection of modifying factors.

M. E. M.

The Noctuidæ of São Thomé.—A. E. PROUT ("A List of Noctuidæ, with Descriptions of New Forms collected in the Island of São Thomé by T. A. Barns," *Trans. Ento. Soc. of Lond.*, 1927, 75, Pt. 2, 201–32, pl. 21 and 1 text-fig.). The specimens recorded were collected between January and October 1926, and there seem to have been practically no previous records of the *Noctuidæ* from this island. In a previous paper in the same journal (pp. 187–200) the writer has dealt with the *Geometridæ*, and the type specimens of both the *Noctuidæ* and *Geometridæ* are in the Hill Museum, Witley, Surrey, England. Ninety-one species of *Noctuidæ* are described in the present paper.
M. E. M.

British Humble-Bees.—O. W. RICHARDS ("The Specific Characters of the British Humble-Bees (Hymenoptera)," *Trans. Ento. Soc. of Lond.*, 1927, 75, Pt. 2, 233–68, pls. 22–25 and 5 text-figs.). The British species of *Bombus* and *Psithyrus* are compared and their specific characters, including many not previously noted, are indicated. The subgenera into which the species have been divided have been further defined; subg. *Terrestribombus* Vogt. has been regarded as synonymous with *Bombus* Latr. s.s., and *Fervidobombus* Skor. with *Pomobombus* Vogt. The genera *Bombus* and *Psithyrus* have been compared, and are shown to differ in numerous morphological characters, of which many appear to be connected with the parasitic mode of life of the latter genus, while others appear to have no direct significance. The genus *Psithyrus* must undoubtedly be derived from *Bombus*. The morphological evidence, on the whole, indicates a monophyletic origin. A study of the habits of parasitic *Aculeata* in general seems, however, to show that each group of *Psithyrus* has arisen from the ancestor of its host species. Though it is very difficult to come to a definite conclusion, a polyphyletic origin seems, on the whole, the more probable. It is suggested that parasitic *Aculeata* as a whole tend to resemble southern races of industrial species in their colour and pubescence. This may indicate that species tend to become parasitic at the northern edge of their range, the adverse conditions there encountered tending to make permanent the temporary and local parasitism which is not uncommon within many species. The specific characters of humble-bees do not appear to have any direct connection with the life-histories of the species. It is not possible, as has been previously attempted, to draw up details of phylogenies of the species of a genus, though it may be possible to define groups (such as the subgenera of *Bombus*) which are probably monophyletic.
M. E. M.

Pyralidæ from South Africa.—J. DE JOANNIS ("Pyralidæ d'Afrique Australe," *Mitteilungen der Schweizerischen Entomologischen Gesellschaft* (*Bulletin de la Soc. Ento. Suisse*), 1927, 14, Heft 1, 181–256, pls. 7 and 8). The author describes a collection of *Pyralidæ* obtained principally from a district of Lourenço Marques, not far from the frontier of Natal, sent to him by Dr. G.-E. Audeoud of Geneva. The series is described as extremely interesting and worthy of detailed study. The collection comprised 594 specimens, 21 of which the author could not identify with certainty. The remaining 573 specimens represent 209 distinct species, with 55 probably new to science. A list of the species is given, and Sir G. F. Hampson's key to the genera of the *Anerastiinae* is included. The paper contains a complete list of the species represented in the collection, and descriptions of the new species. Of the latter, 24 are figured in the accompanying plates.
M. E. M.

Chara and Mosquito Larvæ.—ENRICO FEDERICI ("L'azione tossica delle 'Charæ' sulle larve dei Culicidi," *Redia*, 1927, 16, Nos. 1 and 2 (Anno 6), 17–28). The author has investigated the reputed toxic action of the *Charas* on Culicide

larvæ. Caballero reported in 1919 what he considered a toxic action of *Chara* on mosquito larvæ. The present paper describes experiments and observations, undertaken with a view to investigating the action of *Chara*, both in the laboratory and under natural conditions in Italy. Experiments in the laboratory are said to have given evidence that *Chara* growing in water associated with mosquito larvæ adversely affected the development of the larvæ and killed many. It is further stated that water in which *Chara* has grown becomes toxic to the larvæ, and that the toxicity of this water would appear to be due to a secretion or excretion of slow formation and of fairly stable chemical composition, while a filtrate of *Chara* pounded with vitreous sand is inefficacious. With regard to the investigations under natural conditions by the author, he reports that he has found *Chara* in the canals of Fiumicino swarming with larvæ for the greater part of the year, and that in 1919 Sella made the same observation on a far larger scale. Consequently Federici concludes that in the laboratory the conditions can be adjusted to give experiments the best chance of success, and that it would be very difficult to apply those conditions to an extensive network of canals and ponds. Moreover, he considers it justifiable to conclude that at any rate in zones corresponding to the Roman Campagna the larvicidal action of *Chara* is considerably less intense, less constant, and more limited than that observed by Caballero in certain regions of Spain.

NOTE.—The work and observations of other writers regarding the reputed toxic action of *Chara* indicate that in laboratory experiments there are so many factors to take account of that the death or development failure of the larvæ is not always directly attributable to a toxic action on the part of plants. M. E. M.

Cleptes Nigriventris Buysson (Chrysid.).—W. VON TRAUTMANN ("Ueber *Cleptes nigriventris* Buysson (Chrysid.)," *Entomologische Mitteilungen*, 1928, 17, No. 1, 79). Describes the hitherto undescribed ♂ (four examples) and also the ♀ of the form which Buysson named *Cleptes semiauratus* L. var. *nigriventris*. The differences justify its recognition as a separate species. M. E. M.

New Buprestides in the Deutsches Entomologisches Museum.—ANDRÉ THÉRY ("Buprestides nouveaux du Deutsches Entomologisches Museum (2ème note)," *Entomologische Mitteilungen*, 1928, 17, No. 1, 76-79, 2 text-figs.). Describes two new species, *Chrysobothris nigriventris* n. sp., length 10.5 mm., breadth 4.5 mm., dark olive green. Country: Brazil, State of Sao Paulo. Type (only example known) in the Deutsches Entomologisches Museum. Easily distinguishable from the numerous South American species by the absence of light elytral spots other than those which cover the impressions. This occurs only in a very small number of species. *Anthaxia granulipennis* n. sp., length 7.75 mm., breadth 2.75 mm. Of the group of *A. morio* F. and *A. confusa* Gor., which it resembles in shape. Black, more shiny underneath than on top. Habitat: Tipoliti, Baikal. One specimen, probably ♀, from the former Franklin Müller collection, at present in the Deutsches Entomologisches Museum. Easily distinguishable from all others of the same group by the well-marked furrow of the pronotum and the roughened surface of the elytra. M. E. M.

Platyhelminthes.

Trematoda.

The Trematode Genus Harmostomum.—H. J. WERBY ("On the Trematode Genus Harmostomum, with the Description of a New Species," *Trans. Am. Micr. Soc.*, 1928, 47, 68-81, 1 pl.). A new species, *Harmostomum pellucidum*,

s described from the intestine of a western robin, *Planesticus migratorius propinquus* Ridgway, while the three species *H. dasyuri*, *H. simile*, and *H. pulchellum* Johnston, which were not available to Witenberg (*Zool. Jahr. Abt. f. System*, 1925, 51, 167), are discussed at length.
G. M. F.

The Trematode Family Strigeidæ.—R. C. HUGHES ("Studies on the Trematode Family Strigeidæ (Holostomidæ), No. VII, *Tetracotyle pipientis* Faust," *Trans. Am. Micr. Soc.*, 1928, 47, 42–53, 1 text-fig.). *Tetracotyle pipientis* Faust is a parasite of *Rana pipiens*. Some of the points in Faust's description are corrected and reasons are given for differentiating this worm from *T. crystallina*.
G. M. F.

Some Monostomes from North American Birds.—H. W. MANTER and O. L. WILLIAMS (*Trans. Am. Micr. Soc.*, 1928, 47, 90–93, 1 pl.). *Tracheophilus sisowi* Skrjakin is here reported for the first time from a pintail duck, *Dafla acuta* L., and from North America. A Nesser Scaup duck, *Marila affinis* Eyton, was found to harbour *Typhlocelum cucumerinum* Rud. 1809. A new trematode, *Typhlocelum americanum*, is reported from a shoveller duck, *Spatula clypeata* L.
G. M. F.

Occurrence of Onchocerca Gibsoni (Worm Nodule) in Cattle in Gippsland, Victoria.—H. A. WOODRUFF (*Aust. Journ. Exp. Biol.*, 1927, 4, 271). Nodules of *Onchocerca gibsoni*, hitherto unrecorded in Victoria-bred cattle, were observed in a number of herds examined by the author in South Gippsland and in an area of 60 miles along the coast and 12 miles inland in the neighbourhood of Foster. Further work was being undertaken with a view to determining the limits of the distribution, the biting flies present, and experimental methods of transmission.
J. L.

In Vitro Tests of the Toxicity of Certain Drugs for Hydatid Scolices.—I. CLUNIES ROSS (*Aust. Journ. Exp. Biol.*, 1927, 4, 283–88, 2 text-figs.). The drugs tested (trypan blue, acriflavine, tartar emetic, and emetine) were chosen because (a) they had proved of some value in other parasitic infections, and (b) they could be injected *in vivo* in relatively large doses. Brood capsules and scolices, obtained from hydatid cysts of sheep under aseptic conditions, were added to varying dilutions of the drugs dissolved in saline, and were incubated at 35° C. Acriflavine proved most highly toxic (all scolices in a 1 : 200 solution being dead in two hours, and in a 1 : 10,000 solution in eight hours), and then tartar emetic, emetine, and trypan blue in the order named.
J. L.

Further Observations on the Life-History of the Eye-Worm of Poultry—J. W. FIELDING (*Aust. Journ. Exp. Biol.*, 1927, 4, 273–81). The author considers that there is no continuity of larval life under experimental conditions, and that the eggs hatch, normally, in the gut of cockroaches. Experiments made to ascertain the duration of the life-cycle in these insects showed that the larvæ reach the body cavity 10 to 13 days after the initial feed of eggs, and that after 17 days, when the larvæ had doubled their size, they became encapsulated. They were not infective, however, until between the forty-sixth and the fifty-second days. The larvæ were seen to leave the body cavity of the cockroach actively under the stimulus of heat, which suggested that warmth, and not digestion, was their normal method of liberation in the gut of the definitive host. Egg-laying commenced 38 days after this, and the whole cycle was complete in about 13 weeks.

Pigeons could be infected by feeding with infected cockroaches, but guinea-pigs only when worms were introduced directly into the eye. The distribution of the eye-worm parasites (*Oxyspirura parvovum*, *O. mansonii*) and that of the Surinam cockroach (*Pycnocelus surinamensis*) was very similar. J. L.

Gastrotricha.

The Parasites of Rotifers.—ERNST BUDDE ("Über die in Rädertieren lebenden Parasiten," *Arch. f. Hydrobiol.*, 1927, 18, 442-59, 13 text-figs.). Having in an earlier paper dealt with these Rotifers, which lead a more or less directly parasitic life upon other organisms, either animals or plants, the author has here concentrated in useful form what is already known regarding organisms which are endo-parasitic upon rotifers themselves, including not only those which have been previously described and named, but also those others which have been recorded in various works without having received names. The majority of these parasites are either sporozoa or bacteria, but in one case a worm-like organism had been imperfectly studied. Four species new to science are now described. Two are sporozoa, viz., *Plistophora brachionus*, which attacks both *Brachionus angularis* and *B. amphiceros*, and *Leptoclava parasita*, which infects *Rotifer vulgaris* and *R. hapticus*. Two are bacteria, viz., *Sociococcus rotarius*, which also infects *Rotifer vulgaris*, and *Entobacter inflans*, which attacks *Brachionus amphiceros*. D. B.

New or Rare Rotifers in Russia. II.—N. N. FADEEV ("Materialy k poznaniyu fauny kolovratok S.S.S.R.," *Trudy Kharkovskogo Obshchestva Ispytatelei Prirody pri Ukrglavnauke*, 1927, 50, 2, 3-17, 2 pls.) (See *J. Roy. Micr. Soc.*, 1926, Ser. 2, 46, 58). The author gives details of 19 new or rare Rotifers, most of which are additions to the Russian fauna. The new species, fully described and figured, are *Monostyla rotunda* and *Colurella ornata*. The former has a very close relationship with *M. stenroosi* Meissner and *M. unguitata* Fadeev. It may be pointed out that the three species will require very careful examination for their identification, if, as is not impossible, the more recently described forms do not prove, when *M. stenroosi* has become better known, to fall within its range of variation. In its general form *Colurella ornata* bears some resemblance to *C. bicuspidata*, but is smaller than the typical examples of that species, and the surface of the lorica is stated to have a very characteristic marking, arising apparently from thickenings of the cuticle. Among the other species recorded, *Lecane methoria* Haring and Myers, *L. infula* H. and M., and *Monostyla opias* H. and M., all recently described for Wisconsin or other North American States, are new to Europe. Fadeev reports that in the neighbourhood of Kharkov he has found the *var. tropica* Apstein of the widely known *Keratella quadrata* O. F. Müller. He draws distinctions between the *var. tropica* and the *var. valga* Ehrenberg, and further subdivides the *var. tropica* into a typical form and four other *formae* to which he assigns names. He also contrasts a series of characters distinctive of the cosmopolitan *Trichocerca longiseta* Schrank with the corresponding details of the rare *T. rosea* Stenroos, and figures both species to establish their respective validity, which had been doubted in some quarters. D. B.

The Rotiferan Sub-family Dicranophorinæ.—H. K. HARRING and F. J. MYERS ("The Rotifer Fauna of Wisconsin. IV. The Dicranophorinæ," *Trans. Wis. Acad. Sci., Madison*, 1928, 28, 667-802, 27 pls.). The present instalment of the comprehensive work which is fast revolutionising the current knowledge of rotifers, completes up to date the revision of the great family of the Notommatidæ. The sub-family Notommatinæ, to which had

been devoted the first and second instalments, has now added to it the new genus *Itura*, represented by five species and having for its type the species well known to most workers as *Eosphora aurita*. The remainder of the issue is occupied by a review of the genera belonging to the sub-family Dicranophorinæ and containing those species of the Notommatidæ whose jaws are of the forcipate type and can be thrust forth from the mouth for one-half their length or more. Many of these species are carnivorous and more than one of them are capable of attacking with success small Cladocera such as *Chydorus*. As now shown, the sub-family Dicranophorinæ includes the following genera: *Dicranophorus* (with 37 species), *Streptognatha* (1), *Erignatha* (4), *Encentrum* (20), *Aspelta* (11), and *Albertia* (1). Each species is described in full detail and figured in lateral view (the most characteristic in this group), together with their respective trophi, which in practically every case are of distinctive form. Of the total of 79 species (Notommatinæ 5, Dicranophorinæ 74), no fewer than 59 are new to science and, with few exceptions, have been found as yet only in the United States. Species which are known in Europe are relatively few. The authors point out that they have included only those species which they have themselves examined, and they give a long list of forms, mostly European in habitat, which have not yet come under examination by them. While they suggest that many of these are insufficiently described, it seems probable that enough of them will be found capable of identification and subsequent redescription to augment considerably the above-stated totals for the different genera of the sub-family. We are informed, further, that more new species of this group are constantly being discovered. A large proportion of the new species are being found in neutral or slightly acid or soft waters, and this has induced the closer study of the waters of the various pools, etc., searched in respect of their pH concentration. There is a growing belief that the degree of such concentration has much to do with the well-being of many species of rotifers and is accordingly a powerful influence on their distribution.

D. B.

Protozoa.

Four New Flagellates.—W. CONRAD ("Quatre flagellates nouveaux," *Annal de Protist.*, 1928, 1, 11-18, 19 text-figs.). Four new species, *Chromulina echinocystus*, *C. fusiformis*, *Conradiella gracillis*, and *Scherffelia cornuta*, are described.

G. M. F.

The Determination of Movements.—P. A. DANGEARD ("Le déterminisme des mouvements chez les organismes inférieurs," *Annal de Protist.*, 1928, 1, 3-10, 4 text-figs.). *Euglena*, when exposed to the spectrum, collects in the most highly refracted region, due to the absorption of the rays by the xanthophyl contained in the chloroplasts.

G. M. F.

Photosynthesis of Diatom Cultures.—S. M. MARSHALL and A. P. ORR ("The Photosynthesis of Diatom Cultures in the Sea," *J. Marine Biol. Assn.*, 1928, 15, 321-60, 24 text-figs.). Experiments carried out on the photosynthesis of diatom cultures at different depth in the sea lead to the conclusion that in the latitude of Millport, in inshore waters, the compensation point lies at a depth of from 20 to 30 metres in summer. As the surface is approached, the increasing light enables more photosynthesis to take place, but this increase only goes on up to a certain depth. There is no point which can be considered as the optimum but a range extending over two or three metres. Above this, light is too strong and photosynthesis falls off again. Even at midwinter the midday sun is injurious at the surface, the compensation point lying just below the surface.

G. M. F.

Tropism in Planarians.—K. E. CARPENTER ("On the Tropisms of Some Freshwater Planarians," *Brit. J. Exp. Biol.*, 1928, 5, 196–203, 2 text-figs.). The tropistic reactions of three Planarian species occurring in Cardiganshire streams, *Planaria albissima*, a common and generally distributed type, and *Pl. alpina* and *Polycelis cornuta*, two Ice Age relicts whose occurrence is almost entirely confined to the vicinity of springs, have been studied with a view to determining their ecological significance. All three species gave the responses characteristic of the whole group of Tricladida to light contact and chemical stimuli. They differ to a considerable extent in their reactions to a current of water, *Pl. albissima* giving the characteristic positive reaction to a strong current, negative to a weak one, while the two glacial relicts exhibit a strong and constant negative rheotropism. These two species also show far greater sensibility to extremes of temperature than does *Pl. albissima*, as well as a more delicate perception of certain chemical stimuli. Their tropisms, as a whole, are in logical agreement with the facts of their occurrence only in environments of a very definite type and with a partial seasonal migration, down-stream in winter, up-stream in summer, which has been found to occur in the Aberystwyth district. G. M. F.

Reactions of Opalina to Media.—M. E. LARSON ("Reaction of Opalinas to Various Laboratory Culture Media," *Trans. Am. Micr. Soc.*, 1928, 47, 1–10). *Opalina obtriginoidea* can be maintained outside its host for various lengths of time depending on the culture medium used. Putter's fluid (containing Rochelle salts), Locke's fluid, or 33·3 p.c. sea-water, are the best common laboratory media. A modified serum-saline-citrate medium is, however, preferable. When culturing in a fluid which does not contain serum, a piece of the cloacal wall of the host will increase the longevity of the cultures. G. M. F.

The Genus Ceratobulimina.—J. A. CUSHMAN ("Some Notes on the Genus Ceratobulimina," *Contrib. from Cushman Lab. for Foraminiferal Research*, 1927, 3, 171–9, 2 pls.). The following species of the genus Ceratobulimina are described: *Ceratobulimina cretacea* Cushman and Harris, n. sp., *C. perpleza* Plummer, *C. eximia* Rzehak, *C. alazanensis* n. sp., *C. contraria* Reuss, *C. hauerii* d'Orbigny, *C. hauerii* d'Orbigny var. *australis* Cushman and Harris, n. sp., *C. dehiscens* Heron-Allen and Earland, and *C. pacifica* n. sp. G. M. F.

Trimorphism in the Foraminera.—J. A. CUSHMAN (*Contrib. from Cushman Lab. for Foraminiferal Research*, 1927, 3, 165–7). It is urged that new species should not be described from a single or even a few specimens, since there is evidence that each species may contain three forms—a microspheric form resulting from the union of flagellisporos with a microspheric proloculum, a megalospheric form with a large proloculum, and gradations between the two extremes. G. M. F.

Photic Stimulation in Volvox.—S. O. MAST ("Reversal in Photic Orientation in Volvox and the Nature of Photic Stimulation," *Zeitschrift f. vergleich. Physiol.*, 1927, 5, 730–8, 1 text-fig.). If colonies of Volvox which are positive or negative in any given luminous intensity are kept for some time in that intensity, orientation ceases, i.e. they become adapted or neutral in reference to orientation; and if the intensity is now slowly changed, they remain neutral, but if it is rapidly changed, they orient again as follows: (a) If the intensity is rapidly decreased and held, they become negative, then momentarily neutral, then positive and finally permanently neutral. (b) If the intensity is rapidly increased, they become positive, then momentarily neutral, then negative and finally permanently neutral. The

greater and the more rapid the change of intensity, the shorter the time they remain positive and the longer the time required to become neutral permanently. (c) If the intensity is rapidly increased or decreased, held for a few moments and then brought back to the original condition, the colonies become positive or negative just as they do if the changed intensity is permanently held ; but after they have become positive or negative, they usually remain so until they become permanently neutral.

G. M. F.

A Parasite of the Euglenidæ.—J. B. MITCHELL, Jr. ("Studies on the Life History of a Parasite of the Euglenidæ," *Trans. Am. Micr. Soc.*, 1928, 47, 29-41, 3 pls.). An endoparasite of *Euglena* is described which may have led earlier workers to postulate a sex phase for *Euglena*. It is probable that the parasite should be more properly placed among the Sporozoa and more specifically the Haplosporidia. There is apparently no limit to the number of parasites which may infect one *Euglena* except the size of the flagellate.

G. M. F.

BOTANY.

(Under the direction of A. B. RENDLE, D.Sc., F.R.S.)

GENERAL.

Cytology.

Nicotiana Hybrids.—T. H. GOODSPEED and R. E. CLAUSEN ("Interspecific Hybridisation in *Nicotiana*. VI. Cytological Features of *Sylvestris*-*Tabacum* Hybrids," *Univ. Calif. Publ. in Botany*, 1927, 11, 127-40, 9 text-figs.). *Sylvestris* × *Tabacum* produces an F_1 closely resembling *tabacum* in external morphology and completely self-sterile. The haploid chromosome numbers for *sylvestris* and *tabacum* are 12 and 14 respectively. In the heterotypic metaphase of the hybrid 24 chromosomes are present, 12 bivalents and 12 univalents. There is no division of the univalents during heterotypic anaphase, in which random distribution of entire univalents takes place. The F_1 *sylvestris*-*tabacum* hybrid was back-crossed to *sylvestris* and produced a progeny of 21 plants. In each case 12 bivalents were present at heterotypic metaphase, and a varying number of univalents from 0-12. The data presented confirm the belief that the bivalents are 12 *sylvestris* + 12 *tabacum*, and the univalents the remaining unpaired 12 *tabacum* chromosomes, i.e. that chromosome conjugation is similar to the type displayed by the *paniculata*-*rustica* *Nicotiana* hybrids, both series falling under the "Drosera scheme." J. L.

Chromosomes of *Nicotiana*.—MABEL L. RUTTLE ("Chromosome Number and Morphology in *Nicotiana*. I. The Somatic Chromosomes and Non-Disjunction in *N. alata* var. *grandiflora*," *Univ. Calif. Publ. in Botany*, 1927, 11, 159-76. 8 text-figs.). The somatic chromosome number of *Nicotiana alata* var. *grandiflora* is 18. These can be divided into three groups on the basis of distinct differences in chromosome morphology. In group 1 there are two pairs of long chromosomes with median constrictions; in group 2, one pair (probably two) of medium-sized chromosomes bearing satellites; in group 3, five or six pairs of uniform medium-sized chromosomes differing from one another in the position of constrictions and fibre attachments. The haploid chromosome number is nine. Morphological distinctions cannot be observed in the meiotic divisions, as all the chromosomes are small round bodies at both divisions. Non-disjunction occurs in from 3 to 20 p.c. of the pollen mother-cells studied, giving an 8 : 10 distribution of chromosomes. J. L.

Chromosomes of *Viola*.—J. CLAUSEN ("Chromosome Number and the Relationship of Species in the genus *Viola*," *Ann. Bot.*, 1927, 41, 677-714, 82 text-figs.). Thirty species of *Viola* have been cytologically investigated, the chromosome counts being determined from heterotypic divisions and homotypic metaphase stages in the pollen mother-cells. Gingin's method of subdivision of the

genus is followed, species from the following four sections being investigated: *Nominium*, *Dischidium*, *Chamamelanium* and *Melanium*. The following chromosome numbers are known for *Viola* species:—6, 7, 10, 11, 12, 13, 17, 18, 20, 24, 26, 27, 30 and 36. They fall more or less into definite groups, forming a 6-series, a 10-series, and a 12-series. In the *Nominium* section both a 10- and a 12-series occur; in the *Melanium* section a 10- and a 6-series, and also frequent aberrations. Species of the same systematic sub-group usually belong to the same series of chromosome numbers. In the *Melanium* section a new subdivision is made on the basis of investigation of chromosome numbers, the two new groups being the *Calcarata* (the 10-series) and the *Tricolores* (the 6-series). Cases are enumerated where, in the genus, the chromosome counts afford indication as to whether the systematic units in question are different species or not. Some *Viola* hybrids in their reduction division follow the *Drosera* scheme, the univalent chromosomes being distributed between the poles without division. Others follow the *Triticum* type, the univalent chromosomes splitting in the heterotypic metaphase. A list is given of all the known chromosome numbers of some 40 species of the genus. J. L.

Chromosomes in Aesculus.—CARL SHERMAN HOAR ("Chromosome Studies in Aesculus," *Bot. Gaz.*, 1927, 84, 156–70, 3 pls.). The haploid number of chromosomes in the genus *Aesculus* is 20. The study of pollen development reveals an abundance of chromosome irregularities (lagging chromosomes and polyspory) and morphologically sterile pollen in species of known hybrid origin. Such irregularities, when found in plants of uncertain origin, are indicative of hybrid ancestry. *A. Hippocastanum*, *A. glabra* and *A. octandra* have previously been recognised as of specific rank, and show no meiotic irregularities. Cytological evidence supports the systematists' view that the following are hybrids: *A. rubicunda*, *A. rubicunda* var. *Brioti*, *A. octandra* var. *hybrida*, *A. Harbisonii*, *A. mutabilis* var. *induta*, *A. mutabilis* var. *pendulifolia*, and *A. woerlitzensis* (origin unknown). The following forms, considered by systematists to be true varieties, show marked meiotic irregularities characteristic of hybrids: *A. Hippocastanum* var. *Barmannii*, *A. glabra* var. *Buckleyi*, *A. glabra* var. *leucodermis*, *A. discolor* var. *mollis*, *A. octandra* var. *discolor*. In addition, *A. arguta*, *A. flava* and *A. georgiana* show marked hybrid irregularities. *A. rubicunda* and *A. rubicunda* var. *Brioti* are tetraploid forms. J. L.

Meiosis in Wisteria.—MURIEL V. ROSCOE ("Cytological Studies in the genus *Wisteria*," *Bot. Gaz.*, 1927, 84, 171–86, 1 pl., 6 text-figs.). The haploid chromosome number for all species and varieties of *Wisteria* examined is 8. Lagging chromosomes are the only sign of irregularity during meiosis. These are most apparent in *W. floribunda* var. *alba*, and are considered due to incompatibility of the elements constituting the bivalents. All lagging chromosomes are included in the daughter nuclei. High percentages of pollen sterility are apparent. Normal tetraspore formation occurs in all forms except *W. venusta*, in which conditions of polycary (numerous small nuclei) and polyspory (numerous small pollen grains) are observed. On this basis, *W. venusta* is considered to be of hybrid origin. Other *Wisteria* species are considered comparable to the diploid hybrids of *Rosa* and *Salix*, where crossing does not disturb the chromosome behaviour, but after normal microspore formation, sterile pollen may result. This sterility is explained as arising from the qualitative differences of the parental chromosomes. Cytomixis is recorded at various stages of development, chiefly at synizesis, and also between formed tetraspores. Its occurrence at so late a stage has not previously been observed. J. L.

Nucleolar and Chromosome Numbers in Hyacinths.—W. E. DE MOL ("Nucleolar Number and Size in Diploid, Triploid and Aneuploid Hyacinths," *La Cellule*, 1926, 38, 7-64, 3 pls.). Varieties of *Hyacinthus orientalis* possess ability to develop a certain number of nucleoli in their somatic nuclei. This number depends on the genetic constitution of the variety examined. The somatic nuclei of diploid, triploid, and aneuploid varieties exhibit respectively two, three, and three or four nucleoli. In the aneuploid varieties the hypotriploids are characterised by three, the hypertriploids and hypotetraploids by four nucleoli. These respective numbers are never exceeded. The simple nucleoli are of the same size in the diploids, triploids, and aneuploids. The complex nucleoli (those capable of fragmentation) differ in size according to whether the variety is di-, tri-, or tetra-nucleolar. Frequent fragmentation of the nucleoli occurs during active mitosis, indicating close relationship of the division of the nucleolus and that of the chromosomes. The highest possible number of nucleoli is usually attained during early prophase. The constant occurrence of two and three simple nucleoli in diploids and triploids respectively suggests that originally a simple nucleolus together with a haploid set of chromosomes forms a unit. The appearance of three or four nucleoli in the aneuploids, not in association with three or four complete haploid sets of chromosomes, suggests that certain chromosomes of a haploid set determine the presence or absence of the simple nucleolus, i.e. are in closer relationship with the nucleolus than other chromosomes of the same haploid set. J. L.

Chromosomes of Typha.—MURIEL V. ROSCOE ("Cytological Studies in the genus Typha," *Bot. Gaz.*, 1927, 84, 392-406, 2 pls., 14 text-figs.). The fundamental chromosome number of the genus is 15. *T. latifolia* ($n = 15$) shows normal meiosis and uniformly perfect mature pollen when grown apart from *T. angustifolia*. *T. angustifolia* exhibits meiotic irregularities and resultant sterile pollen. The definite haploid number for this species is not established. Intermediate forms appear where these two species are grown in proximity. These show varying degrees of irregular meioses and sterile pollen formation. On the basis of meiotic irregularity, *T. latifolia* is considered a "pure" species, while *T. angustifolia* is probably of hybrid origin. Tetraploidy is exhibited by *T. angustifolia* var. *Muelleri* ($n = 30$). J. L.

Meiosis in Ranunculus.—HELEN SOROKIN ("Variation in Homotypic Division in *Ranunculus acris*," *Amer. Journ. Bot.*, 1927, 14, 565-81, 2 pls.). The seven chromosome pairs found during early diakinesis may be distinguished by size differences. One chromosome pair is connected to the nucleolus, and remains so until disappearance of the nucleolus in late metaphase. In late diakinesis a small black body lies detached from the nucleolus and may represent the bud-like nucleolar protrusion present in earlier prophase. During metaphase numerous globules are scattered in the cytoplasm. By their staining reaction these are not considered to be nucleolar fragments. Reasons are given for considering the chromatin units found during late heterotypic metaphase as representing tetrads of chromatids. Support is given to the theory of transportation of chromosome material from the nucleolus. Two different types of homotypic division are reported: (1) Normal division, seven distinct chromosomes appearing in each anaphase group; (2) division in which the individual chromosomes are not distinct. The author figures this clumped condition of the homotypic chromosomes both by camera lucida drawings and photomicrographs. From the latter, plasmolysis is evident and strongly suggests that this abnormal "type" of division may be artifact. Intermediate types of division are also reported. J. L.

Meiosis in the Hibiscæ.—W. YOUNGMAN ("Studies in the Cytology of the Hibiscæ," *Ann. Bot.*, 1927, 41, 755–78, 3 pls.). An account of the microspore formation in *Thespesia populnea*, undertaken to endeavour to explain the genetic behaviour of the nearly allied genus *Gossypium*. The same chromosome numbers are exhibited by the two genera, though the exact factorial number is not definitely established. The method of chromosome pairing is telosynaptic. Apparently eight twisted loops emerge from a central tangle in "second contraction," and present chiasmatic figures. During prophase the chromosomes pass through a characteristic cross-shaped form, from which they emerge as globular bodies. Thirteen such bodies are present on the equatorial plate of the spindle. They mass together and emerge from fusion as eight bodies. This is considered due to previous transverse segmentation of five of the prophase chromosomes and the recombination of ten half chromosomes in pairs of halves. Three "peculiar chromosomes" are constantly present and show no evidence of division at any stage. Different types of heterotypic anaphase occur: (1) a five-eight division, (2) chromosomes in masses, the individuals unrecognisable, (3) rarely a three-five division. Typically in interkinesis five cross-shaped chromosomes are in each daughter nucleus, and three "peculiar" non-crossed chromosomes also present in one of the nuclei. In the pollen tetrad three nuclei contain 10 chromosomes and one 13. The presence of two kinds of pollen presents the possibility of mutation phenomena. The results obtained indicate that the Hibiscæ are worthy of accurate cytological observations.

J. L.

Wall Formation in Zea Mays.—R. G. REEVES ("Partition Wall Formation in Pollen Mother-Cells of Zea Mays," *Amer. Journ. Bot.*, 1928, 15, 114–22, 2 pls.). Pollen mother-cell protoplasts in young anthers are surrounded by hyaline callose. This constitutes the mother-cell wall, and is thicker in regions where the protoplasts are not in close contact. After heterotypic division, thickenings are formed on the spindle fibres at the equator of the cell. These thickenings fuse and form the cell plate which, following the formation of peripheral spindle fibres, ultimately extends to the mother-cell wall. The cell plate splits, and a homogeneous substance appears between its halves. This substance does not give the pectic reaction of a normal middle lamella, but is identified as callose. Cell plate formation is similar after both heterotypic and homotypic divisions. When mature, the microspores are liberated from the callose wall by its disintegration. There is no quadripartition of the mother-cell by furrowing.

J. L.

Observations on Living Nuclei.—PIERRE MARTENS ("Le Cycle du Chromosome Somatique dans les Phanerogams. III. Recherches Expérimentales sur la cinèse dans la Cellule Vivante," *La Cellule*, 1927, 38, 69–174, 1 pl.). A detailed account of experiments and observations on the living nuclei of the stigmas of various Gramineæ and of the young ovules of the two orchids *Listera ovata* and *Orchis maculata*. The living resting nucleus has a reticulate structure. Granules may be apparent, but are only the points at which the fine threads of the reticulum cross one another. Living resting nuclei were subjected to a fixing fluid under the microscope, and kept under observation during the period of penetration of the fixative. Good fixation accentuates the already existing structures, but does not cause the formation of new nuclear contents. All stages in mitosis have been followed in the living material of *Arrhenatherum elatius* and *Festuca rubra*. The spindle is a homogeneous structure, likewise the cell plate. Controlled fixation is observed to render the chromosomes more clear at all stages, but causes no fundamental alteration in their form. On the other hand, fixation

causes the appearance of the spindle fibres and the granular structure of the cell plate. The following times are given for the accomplishment of the various mitotic stages in *Arrhenatherum*: prophase, 36–45 minutes; metaphase, 7–10 minutes; anaphase, 15–20; early telophase 3–5; telophase and reconstitution of daughter nuclei, 17–30 minutes. J. L.

Pollen Tetrad Formation in *Tropaeolum*.—ALTA BOLENBAUGH ("Microsporogenesis in *Tropaeolum majus*, with special reference to the cleavage process in tetrad formation," *Bull. Torr. Bot. Club*, 1928, 55, 105–15, 2 pls.). The haploid number of chromosomes in *Tropaeolum* is 14. The meiotic divisions proceed quite normally with telosynaptic pairing of homologous chromosomes. During synapsis the mother-cells separate from one another, apparently secreting their own mother-cell walls. A brief historical review is given of work concerning the quadripartition of pollen mother-cells in dicotyledons, either by cell plate formation or by furrowing. In *Tropaeolum* ephemeral cell plates are formed, but shortly disappear and are apparently functionless. Cell division usually occurs immediately after the formation of the tetrad nuclei, and is brought about by means of broad "hour-glass-like" furrows in the cytoplasm, the constriction being formed by the plasma membrane. A special callose wall is deposited around each tetrad, but does not grow in between the microspores. Each young spore is surrounded by a pale staining matrix which is considered to be of tapetal origin. Each microspore forms its own cell wall and is liberated by breaking down of the surrounding special and original mother-cell walls. J. L.

"Double Fertilisation" in *Petunia*.—MARGARET C. FERGUSON ("A Cytological and a Genetical Study of *Petunia*. I," *Bull. Torr. Bot. Club*, 1927, 54, 657–64, 2 pls., 1 text-fig.). Plants of three cultivated strains and one natural species *P. nyctaginiflora* were examined cytologically and revealed a hitherto unrecorded method of "double fertilisation." Prior to the discharge of sperm-nuclei from the pollen-tube, the primary endosperm nucleus formed from the fusion of the two polar nuclei divides. This nuclear division is followed by division of the embryo-sac into a large basal and small micropylar cell. The first sperm unites with the nucleus of the micropylar endosperm cell, the second fertilising the egg in the normal manner. The basal cell undergoes normal mitoses without the stimulus of fertilisation, its derivatives comprising three-quarters of the endosperm tissue at the 16-cell stage. The haploid chromosome number for *Petunia* is 7. The nuclei formed from the basal endosperm cell are of $2n$ constitution, those from the "fusion nucleus" of $3n$ constitution. J. L.

New *Empetrum* Species.—O. HAGERUP ("*Empetrum hermaphroditum* (Lge) Hagerup. A New Tetraploid, Bisexual Species," *Dansk Bot. Archiv.*, 1927, 5, 1–17, 5 text-figs.). The *Empetrum* forms from Northern Europe may be divided into two systematic units: (1) *E. nigrum*, unisexual with 13 haploid chromosomes; (2) *E. hermaphroditum*, bisexual with 26 haploid chromosomes. The latter form has the synonym *E. nigrum* f. *hermaphrodita* Lange. It is now established as an independent species, and its diagnosis given. The limits of geographical distribution for the two species are not yet known. *E. hermaphroditum* penetrates further north, and is found as far north as 79° lat. This is the only form found in West Greenland. Pollen development is described for both species. In *E. nigrum* 13 gemini are present in diakinesis. In heterotypic metaphase these show considerable size differences. An xy pair is distinctly longer and thicker, differing from the others in the inequality of its two members, x being double the size of y . The

anaphase groups show 13 univalents, all the chromosomes being compact and x and y indistinguishable. *E. hermaphroditum* has 26 somewhat rectangular gemini. This increase in number is accompanied by increase in size of both nuclei and spore mother-cells. Two xy gemini are present, and are so orientated that the x and y of each pass to opposite poles, and each daughter nucleus ultimately receives one x and one y chromosome. This fact must almost certainly be connected with the bisexual development of this species. *E. nigrum* develops two kinds of pollen grains, and possibly an egg cell fertilised by a " y grain" produces a male plant, while that fertilised by an " x grain" produces a female plant. *E. hermaphroditum* must be regarded as a tetraploid form of the original species *E. nigrum*. In addition to doubling of the chromosomes, the flowers have simultaneously become bisexual. The theoretical importance of this influence of tetraploidy on sex is indicated. The origin of the tetraploid species may be due to the extreme conditions of temperature in the environment of the plant. On this hypothesis, *E. hermaphroditum* furnishes an instance of external conditions giving rise to the formation of a new species.

J. L.

Mitosis in the Characeæ.—JOHN S. KARLING ("Nuclear and Cell Division in the Antheridial Filaments of the Characeæ," *Bull. Torr. Bot. Club*, 1928, 55, 11-39, 1 pl.). A high degree of synchronism in division is shown by the nuclei of adjoining cells of the antheridial filaments. Nuclear and cell division stages are shown in well-graded series among linear groups of cells. The different cells in each such group display almost complete synchronism in mitotic stages. Seriation occurs in any direction in the filament. The changes observed in the nuclear figures are analysed in terms of colloidal behaviour.

J. L.

Chromosomes of Riccia.—FREDERICK MCALLISTER ("Sex Ratio and Chromosomes in *Riccia Curtisii*," *Bull. Torr. Bot. Club*, 1928, 55, 1-10, 5 text-figs.). *R. Curtisii* is strictly dioecious. On germination, the four spores of a tetrad regularly give rise to two male and two female plants. The separation of the sexes, therefore, occurs at heterotypic division. The chromosome number is eight in both male and female nuclei. The chromosomes show size differences which appear the same in both sexes. Each haploid group consists of two large straight, three medium straight, two smaller curved, and a single very small chromosome. No definite and constant difference is observed between the chromosomes of the two sexes. Similar sex segregation without association of visible chromosome differences is also shown by *Conocephalum* and *Riccardia*.

J. L.

Anatomy and Histology.

Anatomy of Seedling Buds of Quercus.—L. M. LANGDON ("Anatomy of Seedling Buds of *Quercus*," *Bot. Gaz.*, 1927, 84, 187-99, 3 pls.). A study of the origin, course, and relationship of the vascular elements of the bud-scales, leaves and stipules, also of the primary tissues of the stem of *Quercus*. The primary stem of *Q. alba* and *Q. rubra* shows two distinct initial groups, one for the dermatogen and the other common to both perilem and plerome. The primary tissues of the epicotyl have distinct cauline strands only in the early stages of development. When leaves appear on the tip of the stem, their vascular bundles become the dominant bundles of the primary cylinder. The leaf-tissues arise from two initial groups, one for the epidermis and the other for the parenchyma and bundles. The procambial strands of the leaves arise in the bases of the leaf-primordia; differentiation is both basipetal and acropetal. Both species furnish evidence that the character of the node is mainly determined by the nature of the foliar organs.

S. G.

Growth Rings in Tropical Woods.—C. COSTER ("Zur Anatomie und Physiologie der Zuwachszonen- und Jahresringbildung in den Tropen," *Ann. Jard. Bot. Buitenzorg*, 1927, 37, 49–160, and 38, 1–114, 6 pls.). An investigation of the physiology of growth-ring formation in Java, consisting of observations of the periodicity of leaf fall and cambial activity. Sixty-three species of tropical trees and 22 introduced temperate species were studied. In the monsoon region of East Java three types of trees are recognised, those which shed their leaves and stand bare throughout the dry season, those which shed their leaves and immediately produce a fresh crop, and those which remain evergreen all the year round. In the more uniform climate of Buitenzorg (West Java) the resting period is more irregular and the behaviour of individual branches is often completely independent. Some species which change their leaves every eight months in Buitenzorg show an annual periodicity in East Java. A close correlation exists between leaf-renewal and cambial activity. The investigations show that in deciduous trees growth in thickness is immediately preceded by the bursting of the buds. The reverse procedure, which is normal for European species, was not observed in deciduous tropical species. In general, the vigour of the cambial activity is directly proportional to the shoot development. As a rule, only those species which stand bare for a time show well-defined growth-rings. These may be marked by one or more of the following anatomical features: (a) a radial flattening of the late-wood fibres; (b) a narrow band of parenchyma terminating the season's growth; (c) a narrow band of fibres without vessels or parenchyma, often formed at the beginning of the season's growth; (d) a periodicity in the width of alternate bands of fibres and parenchyma; (e) a periodicity in vessel size or arrangement. In early wood the vessels are often larger or more numerous, while sometimes this condition occurs in the middle of the ring. There are relatively few tropical trees in which growth-rings are altogether absent even in a uniform climate. Estimation of the age of a tree by counting the growth-rings cannot be relied on, even when the cycle of seasons corresponds with annual periods, as rings are often incomplete and may be altogether lacking in youth. In the dry monsoon region of East Java the age of many species can be determined to within a few years, while in others the error is within 20 to 30 p.c. European species grown in the constantly humid and cool mountains of West Java are for the most part evergreen, but retain a periodicity in their individual branches. Growth in thickness is related to leaf periodicity, so that the rings in the branches are usually distinct. In the trunk of such trees the rings are irregular, often fusing or ending blindly. Conifers rarely show sharply defined growth zones; the "summer wood" merges gradually into "spring wood" on both sides. From experiments involving ringing, removal of buds, and darkening, it is concluded that the renewal of growth in thickness after a resting period is due to a stimulus emanating from the developing organs by way of the phloem. If the developing organs are removed or isolated by ringing operations, no new wood is developed. Interruption of the flow of sap in evergreens or deciduous trees in leaf has an immediate effect in stopping growth in thickness. Growth in thickness also ceases in sprouting trees whose assimilation is checked by darkening. Renewed growth in thickness of bare flowering trees is often stimulated by the production of new flowers. Artificial rings were produced by the removal of sprouting twigs and buds. This was followed by the development of new buds which stimulated the production of false "spring wood." B. J. R.

Excentric Growth in Branches.—J. H. PRIESTLEY and D. TONG ("The Effect of Gravity upon Cambial Activity in Trees," *Proc. Leeds Phil. Soc.*, 1927, 1, 199–208, 1 pl.). The horizontal stems of many woody Dicotyledons tend to

form more wood elements on the upper side. This effect is ascribed to the position of the branch in relation to gravity, and not to conditions of illumination, moisture, etc. With certain exceptions, gravity increases cambial activity on the upper side in Dicotyledons and on the lower side in Gymnosperms. In both groups it increases the rate of lignification on the lower side. Microscopic observations on woody Dicotyledons show that xylem formed on the upper side of a horizontal branch has the appearance of spring wood except for a narrow zone of wood formed at the end of the season. On the lower side the cells are all so small and so heavily lignified that the successive annual rings are difficult to distinguish. The difference between the wood structure on the two sides of a branch is explained as follows: After the new elements have been cut off by the cambium, differentiation is accompanied by extension in length, a process which depends upon the rate of lignification. This being more rapid on the lower side, the wood elements on this side extend less in length. In this way the wood on the upper side, composed of longer elements, is better adapted to resist tension, while the shorter, thicker elements on the lower side are more resistant to compression. It is suggested that the different behaviour of the cambium in horizontal stems of Dicotyledons and Gymnosperms is correlated with other differences in cambial activity in these two groups which are briefly described.

B. J. R.

Wood Structure of Certain Eucalypts.—M. B. WELCH ("Wood Structure of Certain Eucalypts belonging chiefly to the 'Ash' group," *Journ. Roy. Soc. N.S.W.*, 1926, 40, 147-66, 4 pls.). In Australia the name "ash" is applied to a group of Eucalypts whose chief resemblance to true ash lies in the colour of their timber. In this paper the wood structure of the following species is described: *Eucalyptus Dalrympleana* J.H.M., *E. Delegatensis* R.T.B., *E. fastigiata* Deane and Maiden, *E. fraxinoides* Deane and Maiden, *E. obliqua* L'Hérit., *E. oreades* R.T.B., and *E. regnans* F. v. M. Several of these species have been confused botanically, and it is not surprising that the results have proved disappointing from the point of view of identification on account of the variation which occurs in the wood of the same species. The descriptions deal principally with their microscopic wood structure, illustrated by photomicrographs of transverse sections.

B. J. R.

Anatomy of *Lythrum Salicaria* L.—H. BODMER ("Beiträge zur Anatomie und Physiologie von *Lythrum Salicaria* L." *Beihfte Bot. Centralbl.*, 1928, 40, 1-58, 15 figs.). The anatomical structure and development of the seedling and adult plant are described. The internal and external morphology of the vegetative organs is very largely dependent on environment. No constant anatomical differences were found between the three forms, long, medium, and short-styled. The production of a double ring was induced in the stem of a one-year-old plant by cutting back the developing shoots. Well-marked "Zugholz" was observed in stems under natural conditions of growth as well as in stems subjected to artificial stresses. Typical "Druckholz" was seldom seen.

B. J. R.

Nodal Structure of *Zea Mays*.—A. T. EVANS ("Vascularisation of the Node in *Zea Mays*," *Bot. Gaz.*, 1928, 85, 97-103, 7 figs.). The vascular bundles were stained by causing the vessels to take up a solution of methylene blue. The material was left in a warm place for a few days, when it was found that the tissue had been retted by bacterial action, so that the parenchymatous cells were easily removed by washing. The specimens were then cleaved and examined under a binocular microscope. Single vascular bundles seldom pass through more than two or three nodes without branching. The nodal complex of small branches

arises from vascular bundles at the point of their entry into the node and from smaller peripheral bundles. It is the result of division and subdivision of these small bundles which later anastomose with those from other bundles. B. J. R.

Anatomy of Morphologically Distinct Races in the Gramineæ.—V. E. WILKINS ("Anatomical Studies of Certain Gramineæ," *Ann. Bot.*, 1928, 42, 305–16, 2 pls., 1 fig.). The manner of growth of plants identified as of the same species may vary considerably. It was investigated whether such marked differences in morphology were associated with modifications in internal anatomy. Within the species the internal anatomy of Sweet Vernal grass (*Anthoxanthum odoratum*) is consistently uniform even in plants showing wide variations in morphology and habit. In other words, morphological differences within the species are not apparently associated with variations in internal anatomy. The same rule holds in the case of established races of wheat (*Triticum*). A detailed description is given of the anatomy of Sweet Vernal grass and of the empty glume of the wheat plant. B. J. R.

Microchemical Investigation of Impregnated Wood.—K. OHARA ("Mikrochemische Untersuchungen der mit Kupfervitriol imprägnierten Holzes von *Cryptomeria japonica* Don.," *Jap. Journ. of Botany*, 1927, 3, 323–33, 1 pl.). Microchemical investigation of the penetration of copper sulphate solution into the wood of *Cryptomeria japonica* shows that it follows the tracheids. The solution first enters the summer wood and the rays, and then the spring wood tracheids, where these are in contact with the rays. For the recognition of copper in the wood, three microchemical tests were used, viz., reduction by hydrazine hydrate and the potassium iodide and cupri-cyanate reactions. The last-named was found to be the most sensitive. Material which had been impregnated under pressure for four and a half hours showed that the distribution of copper was as described above. Summer wood tracheids were almost without exception filled with copper compounds, often even to the pit cavities. Microscopic examination of incinerated sections confirmed the results of the chemical investigations. Copper deposited in the lumina of the cells, where it is combined with the cell contents, is not so stable as that in the cell wall. The optical behaviour of the incinerated tracheids agrees with that of the same elements in untreated wood, indicating that the copper is probably adsorbed on the cellulose particles of the cell wall. B. J. R.

The Meristem and its Activities.—J. H. PRIESTLEY ("The Meristematic Tissues of the Plant," *Biol. Rev.*, 1928, 3, 1–20, 8 figs.). A review of the meristem and its activities, based on Schüep's recent monograph. The author has attempted to show each stage in development as dependent on preceding events. A brief consideration of the process of differentiation of the apical growing regions in the lower plants leads up to a discussion of the meristem in the higher plants, with which the paper is chiefly concerned. Meristems of shoot and root show differences in organisation rather than in the constitution of individual cells. The cells of the apical meristem are considered in the light of the two commonest generalisations about cell division, namely, Sachs' law that when a protoplasmic mass divides into two, the two daughter cells will be equal in mass, and Errera's law, which states that when such a cell division takes place, if the dividing cell is in equilibrium with its external surroundings, the dividing wall tends to be of minimum area. The application of this second generalisation throws a new light upon the organisation of the cells of the shoot apex. In the development of the cambium

from the pro-cambial ring certain meristematic cells between the xylem and the phloem, besides dividing transversely in accordance with Errera's law, also divide in a tangential plane, i.e. a division wall forms in a plane of *maximum* area. A tentative explanation of this anomaly is put forward on the ground of the existence of a gradient of hydrogen ion concentration between the differentiating xylem with relatively acid sap and the differentiating phloem with relatively alkaline sap. A similar explanation is applied to the arrangement found in dicotyledonous roots and also to the position of the phellogen, lying between an alkaline phloem on the inside and a relatively acid outer layer formed by the release of fatty acids from the external cork cells.

B. J. R.

Morphology.

Development of Ovule and Embryo-Sac of Cocos.—E. QUISUMBING and J. B. JULIANO ("Development of Ovule and Embryo-Sac of *Cocos nucifera*," *Bot. Gaz.*, 1927, 84, 279-93, 13 figs.). An account of the development of the ovule and embryo-sac at the time of fertilisation. The axis of the flower develops before the emergence of the inflorescence from the outer spathe. The development of the embryo-sac continues until the receptive stage of the stigma. The ovules are cauline and arise from the central axis of the flower, which bulges out and forms papillæ; the latter serve as nucelli and are pushed towards each locus of the ovary. Inner and outer integuments appear in succession. The archesporium is one-celled; it does not cut off any parietal cell, but functions as the megaspore-mother-cell and develops into the embryo sac. Division takes place in the usual way, and produces the eight-nucleate sac, which when mature contains the egg, two synergids, two polar nuclei and three antipodals. The polar nuclei fuse just before the degeneration of the antipodals and the synergids. The synergids are disappearing just before the ovary becomes receptive.

S. G.

Ecology.

Beach Vegetation in the Philippines.—R. KEINHOLOZ. ("An Ecological-Anatomical Study of Beach Vegetation in the Philippines," *Proc. Amer. Philos. Soc.*, 1926, 65, 58-100, 6 pls.). An intensive study of the vegetation and environmental factors of the beach area of Puerto Galera, Mindoro, as typical of the beach areas of the Philippines. The beach was regarded as divisible into three physiographic regions—(1) the sandy beach, (2) rocky headland, and (3) muddy flats. The present paper deals only with the first two regions. The sandy beach has characteristic creeping herbaceous plants such as *Spinifex littoreus* and *Ipomœa pes-capræ*, and on the higher zone at the back shrub-trees such as *Scaevola frutescens*, *Tournefortia argentea*, *Pandanus* spp, etc. The rocky headland has few distinctive species. The average temperature of the beach is fairly low when compared with the interior of the islands, but high when compared with beaches of temperate climates. The ratios of evaporation on the headland, the beach, and in the mangrove swamps are as 100 : 58 : 33. This evaporation is greatly increased by the wind, which is strong and steady, especially on the headland. Intense sunlight, salt spray, and rapid drying of the sand combine to make a very severe environment, especially in regard to water-supply. This environment has affected the habit and more especially the leaf-structure of the plants typical of the beach. The 22 species studied have xerophytic structures, the most conspicuous of which are very thick leaves, nearly half of which are 350 microns in cross-section; water-storage tissue is found in 80 p.c. of the plants, sunken stomata in 45 p.c., while the majority

have thick cuticles. In addition to these more common types of adaptation, many plants have reduced or suppressed leaves, while others are protected by hairs, or a waxy bloom, or a "varnished" cuticle. A number of species have a pronounced hypodermal tissue free from chloroplasts, and this is often accompanied by a mesophyll tissue composed entirely of palisade parenchyma. Mucilage cells are sometimes present both in the epidermis and in the mesophyll, and a few species have store-cells. Stereome tissue is found in the most highly xerophytic species either as masses of cells above and below the veins, or in a narrow band from the veins to the upper and lower epidermis. S. G.

CRYPTOGAMS.

Pteridophyta.

Davalliæ.—EDWIN BINGHAM COPELAND ("Davallodes and Related Genera," *Philipp. Journ. Sci.*, 1927, 34, 239-58, 5 pls.). In this revision of Davalliæ the following genera are recognised:—*Araiostegia*, *Davallodes*, *Trogostolon*, *Leucostegia*, *Humata*, *Davallia*, *Scyphularia*. *Araiostegia* is a new genus, the type of which is Blume's *Aspidium hymenophylloides*; eight other species are transferred to it from *Davallia*, and five more are suspected to belong to it. It is distinguished by its thin much-divided frond, its rhizome scales, and thin indusium. *Davallodes* was created by Copeland in 1908, and is now more accurately defined, and the affinities are discussed at some length. There are grounds for believing that the ancestral line of the Davalliæ is traceable in *Oleandra*. About 12 species, four of which are described for the first time, are referred to *Davallodes*, and a key is supplied for their easier determination. *Trogostolon* is a new genus, the type and only species of which is Presl's *Davallia falcinella*. A new species of *Scyphularia* from New Guinea is described, and four other species are referred to that genus.

A. G.

Calymmodon.—EDWIN BINGHAM COPELAND ("The Genus *Calymmodon*," *Philipp. Journ. Sci.*, 1927, 34, 259-72, 6 pls.) The genus *Calymmodon* was created in 1836 by Presl for the pinnatifid fern *Polypodium cucullatum* Blume, in which the side of the lobe is folded over so as to protect the sorus. It is a Malayan genus, and 12 species are here referred to it, six of them being described for the first time. A key to the species is supplied. *Calymmodon* is well distinguished from *Polypodium* by the stipes of the frond being non-articulate and persistent.

A. G.

Nephrodium libanoticum.—J. B. KÜMMERLE ("Über das Vorkommen von *Nephrodium libanoticum* auf der Insel Cypern," *Botanik. Közlemények*, 1927, 24, (32), (33)). When studying the Mediterranean fern *Nephrodium pallidum* Bory in the Museum at Budapest, the author chanced upon a specimen from Cyprus collected by Sintenis in 1880, and recognised it to be *N. libanoticum* (Rosenst.) Bornm., a fern which formerly was supposed to be confined to the Lebanon range; it is characterised by having its sori marginal and its indusia free from glands. Bornmüller has shown that the species is not confined to Lebanon, but occurs throughout Syria, where it takes the place of *N. pallidum*. Kümmerle adds some old Syrian gatherings to the record of *N. libanoticum*, which latter species does not occur in Asia Minor, but in Cyprus it replaces *N. pallidum*, which harmonises with the fact that there are many Syrian elements in the flora of Cyprus.

A. G.

Adiantum in South Africa.—J. B. KÜMMERLE ("Über das Vorkommen eines australisch-neuseelandischen Farnes in Südafrika," *Magyar Bot. Lapok*, 1927, 25, 145, 146). Alluding to ferns which South Africa possesses in common with

South America, with subantarctic and other lands, for example *Todea barbara* and *Blechnum australe*, which are of Australian and New Zealand type, Kümmerle calls attention to the occurrence in Bechuanaland of *Adiantum formosum* R. Br., a species hitherto known only in temperate Australia and New Zealand. He presumes that this should include the *Adiantum capillus-Veneris* var. *minor* of T. R. Sim's "Ferns of South Africa," 1915, plate 121. Kümmerle names the Bechuana plant var. *Rogersii*, and says it differs from the Australian type by having the sterile pinnules more cuneate at base and more deeply flabellately serrate. A. G.

Botrychium.—FRÈRE MARIE-VICTORIN ("Sur un Botrychium nouveau de la flore américaine et ses rapports avec le *B. Lunaria* et le *B. simplex*," *Trans. Roy. Soc. Canada*, 1927, ser. III, 21 (sect. V), 319-40, 3 pls. and 6 figs.). In North America *Botrychium simplex* is transcontinental in its distribution, being more abundant in the west. *B. Lunaria* is more abundant in north-east America. And now a third species has been discovered in the Mingan Archipelago, where *B. simplex* does not occur. So the new species, here described and figured, *B. minganense*, cannot be set aside as a hybrid of the other two. A key is provided which carefully discriminates the three species from one another and from two variants of *B. Lunaria*. The distribution of these plants in Quebec especially and in the rest of North America is given. A. G.

Bryophyta.

Hybrid Gones.—J. P. LOTSÝ ("On Hybrid Gones and on Homozygous Hybrids," *Ann. Bryol.*, 1928, 1, 133-39, 3 figs.). An appeal to bryologists to be on the look-out for hybrids and their segregates in such polymorphous groups as *Bryum*, *Sphagnum*, *Frullania*. The author has constructed diagrams to show the homozygous hybrids arising from the first cross of parents differing in three respects, and the subsequent segregates all different from one another, 56 being heterozygous and eight homozygous. Barely any experimental work has so far been attempted A. G.

System and Experiment.—L. LOESKE ("System und Experiment," *Ann. Bryol.*, 1928, 1, 127-32). An essay on the importance of studying the variation of moss species in the field, in view of the blunders which have been made in the past by bryologists by attaching specific importance to characters which have since been shown to be due merely to difference of environment, as in case of *Philonotis mollis* and other species of *Philonotis*. In a wet spring-time the author observed *Sphagnum obesum* to arise out of normal *S. rufescens*. The interchangeability of *Polytrichum strictum* and *P. juniperinum* may be seen when the former is transplanted from the moor to a wood, and the second moss from the wood to the moor, and the further development is watched. Similar transplantation experiments are desired in case of related species, such as *Dicranum scoparium* and *D. Bonjeanii*, *Brachythecium salebrosum* and *B. Mildeanum*, *Thuidium delicatulum* and *T. Philibertii*, *Mnium affine*, *M. rugicum* and *M. Seligeri*, *Lophocolea heterophylla* and *L. minor*, etc. A. G.

Treubia.—R. v. D. WIJK ("Morphologische Betrachtungen über *Treubia* und das Blatt der Hepaticæ," *Ann. Bryol.*, 1928, 1, 147-52). The author reviews what has been written upon the morphology of *Treubia*, and refuses to accept that the rounded marginal lobes of the thallus can be leaves. But he would, on the other hand, regard the two rows of obliquely set dorsal scales of the thallus as rudimentary leaves, and as corresponding in origin, position, etc., to the leaves of foliose hepaticæ. A. G.

Cephaloziellaceæ.—CH. DOUIN ("Les Céphaloziellacées européennes," *Ann. Bryol.*, 1928, 1, 49–68). A synopsis of the European hepatics referred to the family Cephaloziellaceæ. The distinctive characters of the family are defined. A key based on the propagula, the leaves and the involucre, is used for discriminating the genera and sub-genera, and keys to each of the four groups of species of *Cephaloziella* facilitate an understanding of the species, varieties and forms of this difficult genus, of which the author has made a special study for several years.

A. G.

Odontoschisma.—A. J. M. GARJEANNE ("Aus dem Leben der *Odontoschisma Sphagni*," *Ann. Bryol.*, 1928, 1, 79–88, 9 figs.). This hepatic occurs frequently in the Netherlands, in tufts or intermingled with *Sphagnum*. The author describes the structure of the plant—the stem, the leaves, the slime-bearing amphigastria—and calls attention to the presence of small paraphyllia on the upper surface of the stem, and to the bands of cells infested with mycorrhiza on the stoloniferous branches.

A. G.

Gemmæ of Hepatics.—A. J. M. GARJEANNE ("Hepaticologische Notizen," *Ann. Bryol.*, 1928, 1, 89, 90). The author has, in Holland, detected gemmæ on hepatics which seldom or never produce them in other countries, e.g. on *Gymnocolea inflata*, *Cephalozia bicuspidata*, *Lophozia excisa*, *Diplophyllum obtusifolium*. He also discusses variegation in hepatics where the pallid leaves or cells are destitute of oil globules.

A. G.

Scapania portoricensis.—TH. HERZOG ("*Scapania portoricensis* Hpe. et G. Eine monographische Studie," *Ann. Bryol.*, 1928, 1, 91–112, 10 figs.). A revision of this hepatic and its allies, with a discussion of the structure of the stem and leaves, the leaf margin and commissure, and reticulation, the perianth, sporogonium, and gemmæ, and finally the distribution. The result is that six tropical American species are reduced to one species with three varieties.

A. G.

Homaliopsis.—H. N. DIXON ("Homaliopsis Dix. and P. de la Varde, gen. nov. Muscorum," *Ann. Bryol.*, 1928, 1, 47, 48). Description of the new genus *Homaliopsis* founded on *Homalia Targioniana* Gough published by Mitten in 1859. It differs from *Homalia* by having a dioicous inflorescence, a hairy calyptra, and a simple peristome of outer teeth only, which are smooth and neither striolate nor papillose. This moss has been wrongly described or misunderstood in the past, and new material from the Palni Hills of South India reveals clearly its distinctive characters.

A. G.

Hymenostylium.—H. N. DIXON ("Hymenostylium xanthocarpum (Hook.) Brid.," *Bryologist*, 1927, 30, 106–109). *Gymnostomum xanthocarpum*, gathered in Nepaul by Gardner, was described and figured by Sir William J. Hooker in his *Musci Exotici*, tab. cliii (1820), and was transferred to the genus *Hymenostylium* by Bridel. The distinguishing characters of the species were the form, colour, and texture of the capsule, the form of the leaves, the structure of the capsule mouth. It is now shown that the orange translucent ovoid capsule can scarcely be distinguished from immature states of the capsule of the variable species *H. curvirostre* (Hedw.) Mitt., which typically has an elongate-elliptic capsule, dark chestnut brown when ripe, and a very long beak abruptly geniculate. In capsule, leaves, and capsule mouth *H. xanthocarpum* agrees with *H. curvirostre* closely, but may be regarded as a slight colour variety. Also *H. aurantiacum* Mitt. must be referred to *H. curvirostre*; *H. micrangium* C.M. is a variety of the same species, and *H. stillicidiorum* (Mitt.) Broth. agrees exactly with *H. curvirostre*.

A. G.

Brotherella and Distichophyllum.—H. GAMS (" *Brotherella Lorentziana* (Molendo) Loeske und *Distichophyllum carinatum* Dixon et Nicholson. Ein Versuch zur kausalen Erfassung engbegrenzter Moosareale," *Ann. Bryol.*, 1928, 1, 69–78, 1 fig.). An investigation of the causes of the limited distribution of the rare moss *Brotherella Lorentziana* (Molendo—*Hypnum*) and of the still more rare *Distichophyllum carinatum* Dix. and Nich. in the Eastern Alps. These species are confined to the kind of habitat required by the more frequent species *Hookeria lucens*, as to climate, altitude, shade, damp atmosphere, etc. It is still a problem how these plants of tropical affinity came to establish themselves in the Alps.

A. G.

Pottia Randii.—C. JENSEN (" *Pottia Randii* Kenn. in Schweden," *Ann. Bryol.*, 1928, 1, 113, 114). This species was first discovered in Maine, U.S.A., and was described and figured in 1899. It has now been found in Bohuslän, Sweden. A full description of the Swedish moss is given, and the suggestion that it is a state of *Desmatodon cernuus* is repudiated.

A. G.

Rhytidium in Russia.—LYDIA SAVICZ (" Sur la fructification de *Rhytidium rugosum* (Ehrh.) Kindb. en Russie," *Ann. Bryol.*, 1928, 1, 140–43). *Rhytidium rugosum* is a moss of very wide distribution in the north temperate zone of Europe, Asia, and America, despite the fact that it never or very rarely fruits, and that it has no reproduction by propagula. Fruit has been found in the past in Norway, Bavaria, and Styria, and now it has been discovered at fourteen localities in the provinces of Transbaikal and Irkutsk, in Siberia.

A. G.

Tortula atrovirens.—H. SCHMIDT (" Ueber einen Fall von Variation anatomischer Merkmale," *Ann. Bryol.*, 1928, 1, 144–46, 1 pl.). Specimens of *Tortula atrovirens* from the neighbourhood of Freiburg, in Breisgau, were found to differ so markedly in the transverse section of their leaf midrib from the figures given by Limpricht, that the author gives a series of drawings for comparison, and discusses the anatomical details.

A. G.

Oligotrichum.—R. v. d. WIJK (" *Oligotrichum incurvum* Lindb. in Holland," *Ann. Bryol.*, 1928, 1, 153, 154). Here is recorded the discovery of *Oligotrichum incurvum* in Friesland, an addition to the moss flora of Holland. It was found in a large patch in a hollow between the sand dunes. At so low a level it is always sterile. Normally a mountain moss, and seldom descending below 1,300 feet, it grows on moist sand or sandy clay, fruiting abundantly. As the sand and clay of North Holland are of Fenno-Scandinavian origin, the question arises as to whether this moss may not be a glacial relict in Holland, especially as it is found in the same province as *Trientalis europæa*, *Cornus suecica*, *Arnica montana*.

A. G.

Polytrichum nigrescens.—A. A. KORCZAGIN (" Etude experimentale de la var. *nigrescens* du genre *Polytrichum*," *Ann. Bryol.*, 1928, 1, 118–26). An elusive *Polytrichum* with black calyptra has been described as *P. commune* var. *nigrescens* by Warnstorf, as *P. inconstans* Hagen, *P. nigrescens* Mikutowicz, and as a variety of *P. Swartzii* or of *P. perigoniale*, which themselves are regarded by Brotherus as varieties of *P. commune*. Loeske believes that var. *nigrescens* owes its dark colour to prolonged inundation. Korczagin has now made experiments in the field by transplanting clumps of normal *Polytrichum* into swamp water rusty with iron, and found that the plants in the following year bore black calyptras. Now Schoenau has shown that the older parts of *Polytrichum* contain tannic acid

and turn brown when grown in alkaline waters. Korczagin concludes that the black colour is due to the action of iron upon tannic acid, and that the so-called var. *nigrescens* is no more than a form or state. A. G.

Friesland Mosses.—D. KOOPMANS-FORSTMANN und A. N. KOOPMANS ("Einige bemerkenswerte Moose aus der holländischen Provinz Friesland," *Ann. Bryol.*, 1928, 1, 115–17). Three new records for the Dutch flora are here given, together with a list of rare species of *Sphagnum*, forms of *Drepanocladus*, and some other mosses. A. G.

Mosses of Hungarian Plain.—A. BOROS ("Ueber den Einfluss der Kultur auf die Moosflora der ungarischen Tiefebene," *Ann. Bryol.*, 1928, 1, 10–12). The Hungarian plain being entirely composed of alluvial sand and clay, without any rocks or erratic boulders, is a very suitable place for studying the effect of cultivation upon the native moss flora. Saxicolous mosses and lichens are absent, save where they have become established on buildings, bridges, etc., of imported stone; thus *Tortula muralis* has become frequent, whilst *Grimmia pulvinata* is rather rare. *Syntrichia ruralis* is a characteristic of reed thatch. Three species of *Cinclidotus* occur on the stonework of the banks of the Danube; so also *Fissidens crassipes* and *Pterigynandrum filiforme*. In pinewood plantations are found *Dicranum undulatum* and *Ptilium cristacastrense*, associated with *Hylocomium proliferum*, *Rytidadelphus triquetrus*, *Hypnopsis Schreberi*, *Scleropodium purum*, *Eurhynchium striatum*. A. G.

Mosses of the Jenissei.—H. WILH. ARNELL ("Die Moosvegetation an den von der schwedischen Jenissei-expedition im Jahre 1876 besuchten Stellen," *Ann. Bryol.*, 1928, 1, 1–9). The author was a member of Nordenskiöld's land expedition to the valley of the Jenissei. The bryological results were published in Sweden in 1885, 1889–90. Field notes on the habitats of the species are now published, arranged in two divisions—the bryophytes of the Perm government west of the Ural Mountains, and those of the country between the Urals and the Jenissei. A. G.

New Japanese Mosses.—V. F. BROTHERUS ("Musci novi Japonici," *Ann. Bryol.*, 1928, 1, 17–27). Descriptions of 25 new species of mosses from the islands of Formosa, Hondo, and Shikoku. A. G.

Mosses of Cashmere.—V. F. BROTHERUS ("Contributions à la Flore bryologique du Cachemire," *Ann. Bryol.*, 1928, 1, 28–46). A list of the mosses collected in the summer of 1913 by Dr. M. Piasenza's expedition to the central chain of the Himalaya of Cashmere. Travelling was very difficult. Borelli's gatherings had to be limited; yet, despite much sterile material, the list contains 106 species and six varieties, and, of these, four species and a variety are new to science, while 35 species and two varieties have never before been recorded for the Himalaya. A. G.

Mosses of New Zealand.—H. N. DIXON ("Studies in the Bryology of New Zealand, with special reference to the Herbarium of Robert Brown, Pt. V," *New Zealand Inst. Bull.*, No. 3, Pt. V, 1927, 239–98). This work on the mosses of New Zealand begins, in the present part, the account of the pleurocarpous mosses, being concerned with the Cryphæaceæ, Neckeraceæ, Lembophyllaceæ, Hookeriaceæ, Hypopterygiaceæ, and several smaller families. Keys to the genera and species are supplied, and descriptive and critical notes. A. G.

Hepatics of Teneriffe.—T. BROEKSMIT ("Les Hépatiques de Teneriffe," *Ann. Bryol.*, 1928, 1, 13–16). A list of 30 hepatics collected in Teneriffe in the early spring of 1923 and 1924, including two species not hitherto recorded for the island, *Scapania nemorosa* and *Frullania microphylla*; while another species, *F. Bryhnii*, has been detected in Leyden Museum which supplies details, previously unknown, as to the spores and elaters. A. G.

Mosses of Belgian Congo.—R. NAVEAU ("Musci Bequaerti I," *Bull. Soc. Roy. Bot. Belg.*, 1927, 60, 11–56, 31 figs.). The first instalment of a report upon the collection of mosses made in tropical Africa, more especially in the Belgian Congo, by Prof. J. Bequaert of Harvard University. The number of species enumerated is about 160, including 35 new species and some varieties and forms, in the description of which H. N. Dixon and I. Thériot have collaborated. Critical remarks are appended to several of the species. A. G.

Thallophyta.

Algæ.

Peridiniæ of France.—M. LEFÈVRE ("Contribution à la flore des Péridiniens de France," *Rev. Algol.*, 1925, 327–42, 2 pls. and 1 fig.). An account of some Peridiniæ collected in three French localities—Haute-Savoie, Paris region, and Somme region—including five genera, 18 species, and several varieties and forms. The novelties are two species and two varieties. *Peridinium cinctum* and *P. palatinum* are critically discussed. A. G.

Swedish Diatoms.—STELLAN ERLANDSSON ("Till Västergötlands diatomacéflora. I. Skövde-trakten," *Arkiv Bot.*, 1927, 21A, No. 4, 1–33, 6 figs.). A contribution to the diatom flora of Westgotland, the present instalment being confined to the district around Skövde, west of Lake Vetter. From 56 gatherings an enumeration of 191 species and 223 forms was obtained. The distribution is discussed. A. G.

Red Bodies in Cyanophyceæ.—A. C. J. VAN GOOR ("Contribution à la physiologie des Cyanophycées. Sur les pseudo-vacuoles rouges et leur signification," *Rev. Algol.*, 1925, 2, 19–38). In some of the plankton blue-green algæ, which form water bloom, are found irregular red corpuscles, the nature of which has been disputed. Richter (1894) thought they were sulphur bodies. Klebahn and Strodtman (1894–6) held them to be gas vacuoles which aid the algæ to rise to the surface. Richter (1895) changed to the view that they were cavities in the protoplasm and that the red colour was due to chromatic aberration. Molisch (1903) maintained that they were of a viscous protoplasmic liquid nature, lighter than water; he called them Schwebekörperchen. Fischer (1905) regarded them as carbohydrate products of assimilation—pseudomitoses. Lemmermann styled these doubtful bodies pseudovacua. Dr. van Goor gives an account of the experiments he made for testing these hypotheses, and states that only Molisch's hypothesis agrees with the facts; the pseudovacua must be of a viscous nature and contain no gas. The red colour is not due to optical defects, but is proper to the pseudovacua. The significance of the latter remains unexplained, but it is certain that in some way they are the direct cause of the disposition of these blue-green algæ to rise to the surface of the water. A. G.

Spelæopogon.—YAJNAVALKYA BHARADWAJA ("Spelæopogon Kashyapi, n. sp., a new member of the Scytonemataceæ," *Ann. Bot.*, 1928, 42, 69–74, 2 figs.). Description of a blue-green alga which appears late in August each year as an epiphyte

on *Ceratophyllum* at Benares. It belongs to the Scytonemataceæ, and differs from *Plectonema* by possessing heterocysts, but not at the points of ramification (thereby excluding *Tolypothrix*). It differs from *Campylonema* in the shape of the filaments and the ramification, and from *Scytonema* also in having single, not geminate, branches. It resembles *Spelæopogon*, but is distinguished from the other species by having an aquatic habit. A. G.

Sigmoid Forms of Closterium.—GEORGES DEFLANDRE ("Sur l'existence de formes sigmoïdes parallèles chez plusieurs *Closterium*," *Rev. Algol.*, 1925, 2, 158-63, 2 figs.). A description of two new sigmoid forms of desmids found finally in a culture in which a number of plants had developed in succession and died out. These sigmoid forms belong to two different species—*Closterium Leiblinii* and *Cl. acerosum*—and the interesting point is that two different species, subjected to the same conditions, have developed in the same manner and have simultaneously given rise to parallel sigmoid forms which are not due to accident. Sigmoid forms of other species of *Closterium* have been recorded. A. G.

Desmideæ of France.—J. COMÈRE ("Additions à la Flore des Desmidiées de France," *Rev. Algol.*, 1925, 2, 310-26). A systematic catalogue of 201 desmids new to the flora of France and not recorded in works published previously to the year 1901. A bibliographical index is also given, in which are chronologically arranged 46 publications issued during the period 1901-25. A. G.

Terrestrial Algæ.—JOAN FRAYMOUTH ("The Moisture Relations of Terrestrial Algæ. III. The Respiration of Certain Lower Plants, including Terrestrial Algæ, with Special Reference to the Influence of Drought," *Ann. Bot.*, 1928, 42, 75-100, 6 figs.). An account of some experiments made upon *Trebouxia*, *Prasiola crispa* (*Hormidium*-stage), *Parmelia physodes*, and a *Hypnum*, in order to determine the effect of severe drought upon their rate of respiration. A description is given of the apparatus employed and of the precautions adopted to eliminate errors. A. G.

Soil Algæ.—B. MURIEL BRISTOL ROACH ("On the Algæ of Some Normal English Soils," *Journ. Agric. Sci.*, 1927, 17, 563-88, 1 fig.). An investigation of the algal flora of four English soils, at Rothamsted Experimental Station; by means of dilution cultures of freshly gathered samples of soil from the top, second, fourth, sixth and twelfth-inch depths. By the method of counting adopted, it was found that the green algæ and diatoms were distributed throughout the 12 in., but were much less numerous at depths of 6 and 12 in. than at 4 in. or at the surface. Unmanured soil yielded the same main species as did the adjacent manured soil, but poorer in numbers of individuals. Thirty-five species are described from each plot, and can be divided into two groups—true soil forms and casual species. Of the true soil forms, some grow equally well on the surface and in the lower layers, while others are more numerous on the surface than deeper. In two of the soils the blue-green species were less conspicuous. Many of the algæ in the soil exist in a vegetative rather than a resting condition. Biological notes on the more interesting species include *Chlamydomonas glaucocystiformis*, *Trochiscia*, *Chlorella*, *Characium*, *Chlorococcum humicola*, *Chlorochytrium*, *Pleurococcus vulgaris*, *Protococcus viridis* Ag. (= *Pleurococcus Nægeli* Chod.), *Heterococcus viridis*, *Bumilleria sicula*. A. G.

Algæ of Canton Zürich.—EDW. MESSIKOMMER ("Beiträge zur Kenntnis der Algenflora des Kantons Zürich. II. Folge: Die Algenvegetation des Böndlerstück," *Vierteljahrsschr. Natur. Ges. Zürich*, 1927, 72, 332-53, 2 pls.). A report

on the algæ collected in a marsh called Böndlerstück. The enumeration contains 275 species and some 30 varieties and forms, arranged in synoptical tables showing the relative frequency, the plant associations, the depth of water or soil conditions, etc., of their habitats. The new forms are described and figured, and a bibliography is appended. A. G.

Algæ of Lake Baikal.—CONST. J. MEYER ("Sur l'Endémisme de la Flore algologique du Lac Baikal," *Rev. Algol.*, 1925, 2, 241-57, 10 figs.). While the fauna of Lake Baikal has been shown to be rich in endemic genera, the flora had been supposed to contain little of interest. But researches made in the past twelve years have brought together many new and peculiar forms of algæ from the waters of Lake Baikal. The present paper gives a series of examples of the endemism of the algological flora of the lake. Among the Chlorophyceæ six new species of *Draparnaldia* are described and one of *Chatomorpha*. The genus *Tetraspora* has yet to be investigated. The diatoms constitute 85 p.c. of the algal flora. The most abundant species is *Melosira baicalensis*, a new species, other notable forms being a large variety of *Cyclotella striata*, a *Gomphonema*, and two forms of *Cymbella*. A thorough exploration of the lake is certain to yield rich results. A. G.

Hungarian Algæ.—E. KOL ("Fragmenta Algologica Hungariæ. I. "Ewige Regen" vallis Felkaënsis," *Magyar Bot. Lapok*, 1927, 25, 261-6, 1 pl.). A list with brief descriptions of 25 freshwater algæ collected at "Ewige Regen" in Felkertal, in Magas Tatra. Several of them occur on glaciers and snow in other countries, and 13 of them are additions to the Tatra flora. A. G.

Hungarian Characeæ.—FERD. FILARSZKY ("Ueber einige Characeen am Fusse der Hohen Tatra," *Magyar Bot. Lapok*, 1927, 25, 9-14, 1 pl.). Among Characeæ collected in the rich botanical district at the south-west foot of the Hohen Tatra was a new species, *Chara scepusiensis* Fil., which is described in detail and figured. It belongs to the group *Charæ perfecte corticatæ*, *Diplostichæ*, *Tylacanthæ*. Also in the same district were found six new forms of *Ch. fetida*. A. G.

Caulerpa prolifera.—M. A. RAPHELIS ("Sur la végétation du *Caulerpa prolifera* (Forsk.) Lamour," *Rev. Algol.*, 1925, 2, 170-4). The author contends that *Caulerpa prolifera* in the Mediterranean is not a rare visitor from the tropics, but is perfectly acclimatised and established at certain places on the coast of France between Marseilles and the Italian frontier. For instance, just to the east of Cannes there is a very large colony of more than a thousand square metres growing on mud, which is very rich in diatoms, almost to the exclusion of other algæ. In winter the yellowish rhizomes of the *Caulerpa* remain quiescent, but during January they produce little green laminæ, which grow rapidly and attain full size by mid-summer. In September these laminæ show yellow spots which spread, and decay sets in. The alga has now invaded the harbour of Cannes, and there is a possibility that this may be due to the practice of the fishermen in cleaning their nets of algæ upon return to port. A. G.

Batrachospermum.—GONTRAN HAMEL ("Floridées de France IV, *Rev. Algol.*, 1925, 2, 280-309, 2 pls., 3 figs.). An account of 26 species of *Batrachospermum* and one of *Thorea*. Whether the genus *Sirodotia*, created by Kylin in 1912, occurs in France is at present unknown. The structure of *Batrachospermum* is discussed in detail. As in Sirodot's monograph (1884), the species are arranged in two groups according as there are one or several gonimoblasts in each verticil, and each group is divided into sections according to the shape of the trichogyne. A. G.

Cytology of Rhodymenia.—M. ALISON WESTBROOK ("Contributions to the Cytology of Tetrasporic Plants of *Rhodymenia palmata* (L.) Grev., and some other Floridæ," *Ann. Bot.*, 1928, 42, 149-72, 1 pl., 8 figs.). A description is given of the course of somatic division in tetrasporic plants of *Laurencia pinnatifida*, *Chondria dasyphylla*, and *Rhodymenia palmata*, and is compared with that in other genera of Floridæ. The nuclei are small, the chromosomes small and numerous, and a spireme stage is absent. Stages in the prophase of the first division of the tetrasporangium are described for *Laurencia pinnatifida* and *L. hybrida*, *Chondria dasyphylla*, *Stenogramme interrupta* and *Rhodymenia palmata*. For all but *Stenogramme* spireme stages are figured and evidence of meiosis is given. In the tetrasporangia of *Rhodymenia palmata* a peculiar stage is described and compared with the "growth period" of some animal oocytes, where the nucleus, after developing a spireme, returns to an apparently resting stage. A process of regeneration of the tetrasporangium is reported for *R. palmata*. The life-history of *R. palmata* is anomalous. Only male and tetrasporic plants have been found, but the cytological results here recorded point to a nuclear fusion in the life-cycle. The occurrence of female plants is suggested, though as yet they have never been identified. A. G.

Aerocysts and Inflations of Fucus.—J. RICHARD ("Les aérocysts et les boursoufflures des Fucus," *Rev. Algol.*, 1925, 2, 136-45, 3 figs.). An account of the structure and physiology of aerocysts which are peculiar to *Fucus vesiculosus*, and of the elongated inflations ("boursoufflures") which are sometimes found in *F. platycarpus*, *F. ceranoides*, etc. The aerocysts are normal, are developed on a definite plan, the air-cavity being enclosed by thick-walled tissue, and they serve to support the plant in the water. The inflations, on the other hand, are ill-defined accidental formations, due to tearing of the central tissue by the expansion of included gas under the influence of sun-heat, when young fronds are exposed at low tide. When pressure is applied, the gas of an aerocyst escapes with a pop, whereas the gas of an inflation is driven into the adjacent tissue. The inflations serve no function, and hasten the drying and destruction of the frond. A. G.

Algæ of Florida.—WILLIAM RANDOLPH TAYLOR ("The Marine Algæ of Florida, with special reference to the Dry Tortugas," *Carnegie Inst., Washington, Publ.*, 1928, No. 379, 1-220, 37 pls., 3 figs.). The author spent parts of three summers at the Dry Tortugas Laboratory of the Carnegie Institution, collecting algæ on the reefs. These he has worked up into a monograph extended to include all the species known to occur on the coast of Florida and the Keys which lie between Florida and the Dry Tortugas. The number of species recorded is about 400, with 60 varieties and forms. There are short descriptions of the genera and species, with keys to facilitate the determination of specimens; but it is the abundant supply of figures representing nearly all the algæ of the region which will be of the greatest assistance to students. The ecological and geographical features of the region are discussed in the introductory chapter. A preliminary account of the algal flora of the Dry Tortugas was published by the author in 1925 (*Rev. Algol.*, 2, 113-35). A. G.

Fungi.

Study of Phytophthoræ.—S. F. ASHBY ("The Oospores of Phytophthora Nicotiana Br. de Haan, with Notes on the Taxonomy of *P. parasitica* Dastur," *Trans. Brit. Mycol. Soc.*, 1928, 13, 86-95, 6 text-figs.). Ashby recounts the discovery by de Haan of oospores in cultures of *Phytophthora Nicotiana* from a seed-bed disease of tobacco in Sumatra and at Buitenzorg, Java. Later workers failed to find any oospores. The fungus occurred recently in Florida, and from a

culture Ashby isolated 23 oospores. Comparison with *P. parasitica* indicates that the fungus from tobacco is identical, and should be included in that omnivorous species. The oospores from many cultures have been measured and compared. It was found that they fall into two series: (1) *Microspora* having oospores of a mean diameter under 20μ with a range of $12-24\mu$, and (2) *Macrospora* having a mean diameter of 20μ with a range of $20-35\mu$. A table is given of spore sizes on different media. A. L. S.

Phytophthore Propagation by Diseased Shoots.—PAUL A. MURPHY and ROBERT M'KAY ("Some Further Cases of the Production of Diseased Shoots by Potato Tubers attacked by *Phytophthora infestans*, and a Demonstration of Alternative Sources of Foliage and Tuber Infection," *Sci. Proc. Roy. Dublin Soc.*, 1927, 18, 413-22, 1 pl.). The writers describe two cases in which shoots produced by blighted tubers planted in the open reached the surface and led to the dissemination of the fungus. It has been proved also that a tuber produced by a plant from a previously blighted tuber became infected in the absence of any foliage. The fungus retains its vitality in the soil for a long time, and may directly infect the new tubers. The writers also found that *Sciara*, a fly emerging from blighted tubers, carried conidia among its leg bristles and thus provided yet another mode of infection. A. L. S.

Resting-Spores of *Phytophthora infestans*.—PAUL A. MURPHY. ("The Production of the Resting-Spores of *Phytophthora infestans* on Potato Tubers," *Sci. Proc. Roy. Dublin Soc.*, 1927, 18, 407-12, 1 pl.). The present paper records the finding of sexual organs on potato tubers under a variety of cultures, etc.; finally they were found in the soil surrounding potato tubers under conditions which represent those of nature. The organs found were mostly abortive oogonia, but sometimes they contained spores, and antheridia were also present, so that undoubted sexual spores apparently perfectly formed were present as well. The question is still to be answered as to how frequently sexual organs occur and form resting-spores in natural conditions, and to what extent do these spores carry over the disease. All the evidence seems to prove that they are very rare: "antheridia are apparently all but absent, and well-formed resting-spores are rare." A historical account is given of the long search for the resting-spores and of their final discovery by the author of the paper. A. L. S.

Phylogeny of the Ascomycetes.—A. GUILLIERMOND ("Remarques sur la phylogénie des Ascomycètes," *Compt. Rend. Acad. Sci.*, 1928, 186, 512-4, 2 text-figs.). Guillermond bases a new theory of the origin of the Ascomycetes on the development of *Spermophthora Gossypii*. In that fungus there is a primary non-septate mycelium like that of the Siphomycetes. The presence of protein crystalloids and of callose which blocks the filaments at intervals recalls the Mucoraceæ and Peronosporaceæ. Guillermond then describes the formation of gametangia from which are liberated gametes which fuse in pairs, the zygote germinates forming a sporophytic hypha at the extremity of which arises an ascus with eight ascospores. He contrasts this with the development of *Pyronema*, and argues that there is a relation between that fungus and *Spermophthora*. *Dipodascus*, considered also as an ancestor of the Ascomycetes, has a septate mycelium and no sporophyte; it is more highly evolved than *Spermophthora*. A. L. S.

Study of Yeast.—OSCAR W. RICHARDS. ("The Growth of the Yeast *Saccharomyces cerevisiæ*. I. The Growth Curve, its Mathematical Analysis, and the Effect of Temperature on the Yeast Growth," *Ann. Bot.*, 1928, 42, 271-83). The

growth in number and size of yeast cells in pure cultures has been followed and described by the author. Methods of procedure are given. Maximum increase was reached in 100 hours. Cell-volume exceeded cell-number increase for the first 15 hours, then declined until there was the same value at 90 hours. Yeast growth is complex, as it grows in a definitely limited environment, the food-supply being adequate.

A. L. S.

Development of Ceratostomella.—GEORGE B. SARTORIS. ("A Cytological Study of *Ceratostomella adiposum* (Butl.) comb. nov., the Black Rot Fungus of Sugar Cane," *Journ. Agric. Research*, 1927, 35, 577-85, 4 text-figs.). The fungus here described was first determined as *Sphaeronema adiposum*, common in the sugar-cane fields of India. The writer procured specimens from stored seed-cane in Louisiana, and has demonstrated its true position as a Pyrenomycete. It is a weak parasite of little economic importance. Cultures were made and it was found that the perithecium began as a coiled hypha: the fruit body is almost fully formed before the ascogenous hyphae arise. They are at first cœnoctytic, but are later divided into 2-nucleate cells which form the ascus mother-cells, the nuclei finally fusing to form the definitive nucleus of the ascus. The long beak of the perithecium arises from a group of meristematic hyphae at the apex of the perithecium.

A. L. S.

Fungus causing Die-back of Apple Branches.—F. T. BROOKS ("On the Occurrence of *Phaciidiella discolor* (Mont. and Sacc.) Potebnia in England," *Trans. Brit. Mycol. Soc.*, 1928, 13, 75-81, 4 text-figs.). In a previous paper there had been published an account of a pycnidial fungus on apple branches. It has now been proved that it is identical with the pycnidial stage of *Phaciidiella discolor* first described by Potebnia. Brooks, on further investigation at Meldreth, found not only the pycnidia, as before, but the apothecia of the fungus. Cultural work, which is fully described, has shown that *Fuckelia conspicua* and *Pyrenochaeta purpuracea* are both identical with the *Phaciidiella*.

A. L. S.

Notes on Hypoxylon.—C. L. SHEAR. ("Notes on the Synonymy of Some Species of Hypoxylon," *Mycologia*, 1928, 20, 83-7). Shear has found, in his study of this genus, that the form of the stroma is not always a reliable character for determination. He recommends that more attention should be paid to the conidial forms, which are more distinctive. He also finds that the same species has been frequently described under several different names: the well-known *H. coccineum* has eight synonyms.

A. L. S.

Tropical Ascomycetes.—FRED. J. SEAVER ("Studies in Tropical Ascomycetes. IV. Some Hypocreales from Trinidad," *Mycologia*, 1928, 20, 52-9, 5 pls.). The specimens dealt with by Seaver had been collected by him in Trinidad in 1921. They include a series of unusual and interesting Ascomycetes, several of them, collected from plants, being parasitic on the insects that infect the host plants. A new genus and species, *Podocrella poronioides* is described. It resembles *Podocrea*, but with filiform spores; it was found on rotten wood among mosses. A new species of *Nectria*, *N. indusiata*, was collected from a fallen leaf of *Micropolis*.

A. L. S.

Heterothallism and Homothallism.—B. O. DODGE. ("Nuclear Phenomena associated with Heterothallism and Homothallism in the Ascomycete, *Neurospora*," *Journ. Agric. Research*, 1927, 35, 289-305, 3 pls., 5 text-figs.). The genus *Neurospora* was published by Shear and Dodge in a previous number of the

above journal. Of the four species belonging to the genus it has been established that two are heterothallic. The present study deals with *Neurospora tetrasperma*, which is normally homothallic. Four spores are developed in the ascus which are bisexual, each containing two nuclei of different sexes; these divide simultaneously, so that ultimately the spore contains four nuclei. Dodge goes over every stage of ascus development, and has described and figured exactly the position and form of the nuclei as they divide, and before and after spore delimitation. A. L. S.

Study of *Melanospora*.—ISABEL COOKSON ("The Structure and Development of the Perithecium in *Melanospora Zamiae* Corda," *Ann. Bot.*, 1928, 42, 255-69, 39 text-figs.). The fungus studied had been isolated from a sample of Nyassaland cotton. It was not, however, considered to be the cause of the diseased condition of the cotton sample. A complete study of the growth of the fungus is here given. After germinating, a mycelium is formed which bears conidia of *Spicaria* type. The peritheceum arises from stout branches of the aerial mycelium, the archicarp taking a coiled or scolecite form. At a later stage there is a differentiation of the developing tissue into an outer sterile region of multinucleate hyphal segments and an inner central area of binucleate cells. The binucleate cells appear capable of forming asci by direct enlargement and after fusion of the two nuclei. Further development of the asci and of the fruiting body has been followed. The spores when mature are shed into the cavity of the perithecium by the dissolution of the walls of the ascus. A. L. S.

Rusts and Smuts of Bermuda.—H. H. WHETZEL and H. S. JACKSON (*Trans. Brit. Mycol. Soc.*, 1928, 13, 1-32). A residence of a year in Bermuda enabled H. H. Whetzel, not only to collect extensively the fungi of the island, but also to make a series of notes on the various stages of the rust disease and of its effect on the host plants. A study is given of the various collections made in Bermuda from time to time, with a special account of smuts and rusts. Of the former, nine species were collected. None of them are endemic, and most, if not all, represent introductions from various places, including an Australian, a European, and a South American species. The rusts were more numerous, most of them species common along the Atlantic seaboard of North America or the West Indies. A considerable number of new hosts for species already known have been determined. In each case biological notes are given of parasite and host. The determinations were entrusted to H. S. Jackson. A. L. S.

Rust Teleutospores.—CHARLES W. WATERS ("The Control of Teliospore and Urediniospore Formation by Experimental Methods," *Phytopathology*, 1928, 18, 157-213, 2 text-figs.). The formation of teleutospores in rusts has been considered as the autumn resting-spore stage produced in the natural course of development. Waters has tackled the subject experimentally to determine the conditions that would react on the fungus and induce the formation of teleutospores. A detailed account of his work on the subject is given in the paper. In general he found that all the rusts studied were dependent on the photosynthetic activity of the host. Factors such as light, temperature, and moisture (or a complex of these factors), influence the metabolism of the host, causing the fungus to react by changing from the uredo to the teleutospore generation or, under proper manipulation, in the reverse direction. Nine species of rust were used in experimentation in the greenhouse, and the production of teleutospores was successfully controlled. Ten rusts were tested in petri dishes by floating leaves on water or on nutrient solutions. Results varied somewhat in the different rusts, but in three cases a slow reduction of the water supplied induced the formation of teleutospores. Again, the tests for

starch showed that there was an abundance present at the stage of uredospores and a paucity at the time of teleutospore growth. In most of the petri dish experiments teleutospore formation was stimulated—(a) by starvation of the host, with a later addition of food-supply, (b) by sudden transfer of the host leaves from a well-fed condition to a state of starvation, (c) by continuous supply of food with the gradual dying of the host-cells. A considerable list of literature adds to the interest of the paper. A. L. S.

Fungi of Santo Domingo. II. Uredinales.—FRANK D. KERN (*Mycologia*, 1928, 20, 60–82). The fungi were collected in the spring of 1926. Reports on other groups have already been published. In studying the rusts, comparisons were made with those collected in Cuba and in Porto Rico. In all, 86 species belonging to different families and genera are recorded, several of these are new to science. A list of host plants is appended. A. L. S.

Rusts of America.—GEORGE G. HEDGCOCK ("A Key to the Known Aecial Forms of *Coleosporium* occurring in the United States and a List of the Host Species," *tom. cit.* 97–100). The paper aims at making more easy the collection and determination of the *Peridermium* forms of *Coleosporium*. These occur on pine needles, and the author finds that size, shape, and colour are useful as field characters. A list of natural pine hosts for the species included in the key is given. A. L. S.

Study of *Citromyces*.—IRÈNE LIPSKA ("Les effets morphologiques et physiologiques d'action des sulfates sur les *Citromyces*," *Act. Soc. Bot. Pol.*, 1927, 4, 42–59). The influence of sulphates on the mould fungus *Citromyces* has been considered under (1) the habit of the cultures, (2) the microscopic structure of the mycelium, (3) the quantity of conidia formed, (4) coloration of the cultures, (5) the acidity of the media, (6) the amount of sugar formed, and (7) the formation of starch. In conclusion, it was found that the growths in the cultures were deformed, as also the mycelium; that the abundance of conidia, more or less a specific character of *Citromyces*, was but little affected by sulphates, although differences were noted according to the salt used. No instance of mutation was observed in any of the cultures. There was little change in colour production; starch formation is normal in *Citromyces*, but there was no reaction for starch with certain sulphates, such as appears usually in the cell walls of the hyphae. A. L. S.

Fusarium Studies.—W. BROWN ("Studies in the genus *Fusarium*. VI. General Description of Strains, together with a Discussion of the Principles at present adopted in the Classification of *Fusarium*," *Ann. Bot.*, 1928, 42, 285–303). The above title indicates the scope of the paper by Brown. About 40 strains were followed in culture; they were classified into four groups on the basis of their cultural characteristics, and the grouping also agreed with their capacity to parasitise the apple fruit. All the strains are varieties of a single species—*Fusarium fructigenum* Fries. It was found that *Fusarium Salicis* allied to *F. fructigenum* was the result of a saltation, and cannot be regarded as a separate species. The writer concludes that similar revision of other forms would reduce the number of species recorded. A. L. S.

Sexuality in *Coprinus micaceus*.—RENÉ VANDENDRIES ("Le Comportement sexuel du *Coprin micaceus* dans ses rapports avec la dispersion de l'espèce," *Bull. Soc. Roy. Bot. Belg.*, 1927, 60, 62–5). Spawn from European and Canadian sources was mixed, and the results achieved are given in a series of tables. It had been already demonstrated that *Coprinus* is heterothallic, and that there must be

a union of + and - mycelium before fruit formation arises. A series of combinations were made, but in general there was sterility between European and Canadian spawn. Crossing was, however, not always successful with different growths, either European or Canadian. Further publication of the results of experiments is promised.

A. L. S.

New British Heterobasidiæ.—A. A. PEARSON (*Trans. Brit. Mycol. Soc.*, 1928, 13, 69–74, 7 text-figs.) Pearson has given descriptions of nine species of resupinate Basidiomycetes new to Britain, one of these, *Sebacinia subhyalina*, being new to science. Full microscopic details are published of each species. They were all collected in Midland, East or South England.

A. L. S.

Brown Thread Blight.—T. PELCH (*Trans. Brit. Mycol. Soc.*, 1928, 13, 142–3). This is a disease of cacao and kola in West Africa, but could not certainly be identified from the material first sent. R. H. Bunting has collected and transmitted more fully developed specimens, and the fructifications proved to be those of *Maresmus byssicola* n.sp., a diagnosis of which is given.

A. L. S.

Resistance to Fungal Infection.—K. M. CURTIS ("The Morphological Aspect of Resistance to Brown Rot in Stone Fruit," *Ann. Bot.*, 1928, 42, 39–68, 64 text-figs.). The author examined plums, cherries, nectarines, peaches, and apricots with a view to determining the mode of entrance by the fungus into these fruits. Entrance was gained frequently by the stomata, but also, where stomata were not present, by the cuticle, more especially at weaker portions of the cuticle. If the whole cuticle is weak, the stomata are of still less advantage to the entrance of the parasite.

A. L. S.

Mycology of the Congo.—M. BEELI ("Contribution à l'Etude de la Flore mycologique du Congo IV," *Bull. Soc. Roy. Bot. Belg.*, 1927, 60, 75–87, 2 pls.) The species listed are, most of them, new to science. All belong to the Basidiomycetes except two Ascomycetes, species of *Meliola*, a new species and new variety.

A. L. S.

Colombian Fungi.—CARLOS E. CHARDON ("Contribución al estudio de la Flora micologica de Colombia," *Bol. Real Soc. Esp. Hist. Nat.*, 1928, 28, 111–24, 2 pls.). The author sketches the history of mycology in Colombia, and gives a short account of his own journeys and of his collections. He chronicles three Mycetozoa, one new to science, and one *Bacterium* which caused gummosis of *Saccharum officinarum*. The list that follows contains only microfungi, many of them parasitic species, and new to science or to Colombia.

A. L. S.

Dominican Fungi.—RAFAEL CIFERRI and ROMUALDO GONZÁLES FRAGOSO ("Hongos parásitos y saprofitos de la Republica Dominicana," *Bol. Real. Soc. Esp. Hist. Nat.*, 1928, 28, 131–44, 7 text-figs.). The species listed and described in the present contribution are all microfungi. A considerable number new to science are included, and several of these have been figured. Most of the new species belong to the Pyrenomycetes.

A. L. S.

Fungi Aternensis.—MARIO CURZI and MARIA BARBAINI (*Ist. Bot. Univ. Pavia*, 1927, Ser. 3, 3, 147–202, 7 pls.). The fungi recorded, to the number of 274 species, were collected by the authors in Central Italy. The series includes all classes of fungi, though Microfungi are the most numerous. Many new species are described and two new genera—*Massariellops* (Massariaceæ), *Scolecozythia* (Nectriaceæ). Five species of Mycetozoa are included.

A. L. S.

New Italian Fungi.—MARIO CURZI ("De Novis Eumycetibus," *tom. cit.*, 205-7, 2 pls.). The new species, mostly from Northern Italy, are all microfungi parasitic or saprophytic on plants. One new genus, *Longoa*, is described. It is near to *Calosphaeria*, but with superficial perithecia. A. L. S.

Diseases of Grain Crops.—L. R. TEHON ("Epidemic Diseases of Grain Crops in Illinois, 1922-26," *Bull. Ill. Nat. Hist. Survey*, 1927, 17, 1-96, 103 text-figs.). The paper covers a very wide field of investigation as to the prevalence and destructiveness of cereal diseases—rusts, smuts, seab, leaf-spot, etc. The relation of weather—temperature and rainfall—to the attack and virulence of epidemic diseases is taken into account. The writer has concluded, from all the data collected, that an abundant crop is determined chiefly by soil, weather, and proper cultivation. It is only in some exceptional season that disease attack determines the yield. It has been proved also that the correlation between disease development and weather conditions lies mainly with temperature. Thus in 1922, when disease indexes were highest, both mean temperature and total rainfall were highest for the period under observation. A. L. S.

Rhizoctonia Disease.—W. SMALL ("On Rhizoctonia Bataticola (Taub.) Butler as a Cause of Root Disease in the Tropics," *Trans. Brit. Mycol. Soc.*, 1928, 13, 40-68, 2 pls.). The writer has had the opportunity to study the parasitism of this fungus on woody plants in Uganda and in Ceylon, and has come to the conclusion that it is the source of many root diseases commonly attributed to other causes. He suspects its presence throughout the tropics and subtropics on tea, citrus, cacao and rubber, and emphasises the economic importance of the parasite. In Uganda, Small found that generally the fungus occurred alone on the roots of the plants attacked, as also in Ceylon, but in the latter country there are many instances known in which the *Rhizoctonia* is accompanied by one or more fungi. *Rhizoctonia* attacks first the smallest rootlets of the host plant, and travels onwards in the bark and cortex; it thus provides ideal conditions for the attacks of other fungi which cause much damage, though Small considers that these are of secondary importance. The condition of the host plants is cited as hindering or furthering the growth of the fungus, which takes advantage of any weakening caused by undue pruning, or, as in the case of tea, plucking the leaves. The fungus and its affinities are fully described. A. L. S.

Successional Disease in the Scots Pine.—MALCOLM WILSON (*Trans. Brit. Mycol. Soc.*, 1928, 13, 81-5). Wilson has noted several instances in which a tree attacked by fungus or insect was rendered vulnerable to some more deadly parasite. He places on record the succession of troubles that affected a Scots pine at Roxburgh. The tree had been badly planted, causing distortion of the roots. *Fomes annosus* attacked at the collar of the tree, probably through damaged roots. The tree was further attacked by the beetle *Pityogenes bidentatus*, a characteristic parasite of less vigorous trees; in the present case there was low water content brought about by bad planting. The fungus *Ceratostomella Pini* has also been found on the tree; it causes blue colouration of the wood, and was probably carried by the beetle. A. L. S.

Mildew Infection.—SAM F. TRELEASE and HELEN M. TRELEASE ("Susceptibility of Wheat to Mildew as influenced by Salt Nutrition," *Bull. Torr. Bot. Club*, 1928, 55, 41-68, 2 pls., 4 text-figs.). The paper is a study of the influence of environment, such as the mineral constituents of the soil, in inducing a fungus attack. The two main problems concern the susceptibility of the host and the

pathogenicity of the parasite and the effects of nutrition on both. The authors employed a wide range of proportions of three main salts, KH_2PO_4 , $\text{Ca}(\text{NO}_3)_2$, and MgSO_4 , in the culture solutions. When the first leaf expanded, the plant was heavily inoculated with *Erysiphe graminis*. They found that susceptibility to infection varied considerably, according to the kind and quantity of salt supplied. On the basis of dry yield, the least susceptible plants were secured with a solution of 90 p.c. KH_2PO_4 , 5 p.c. $\text{Ca}(\text{NO}_3)_2$, and 5 p.c. MgSO_4 . The most susceptible had only 5 p.c. of the phosphate, but 47.5 p.c. of each of the other salts. The salts that secured optimum growth of the infected plants were different in proportion from those that gave the best growth of uninfected. A. L. S.

Disease of Pear Tree.—MARIO CURZI ("Una Moria di giovane piante di Pero e un Nuovo Genere de Pyrenomycetæ," *Ist. Bot. Univ. Pavia*, 1927, Ser. 3, 3, 73–90, 1 pl., 9 text-figs.). The fungus which caused the death of the tree was sent from Piacenza. Other trees in the neighbourhood had died, while quince trees near by remained unaffected. The fungus attacks the roots and destroys the internal tissues. Cultures and cross-inoculations were made, and these are described. The fungus proved to be a Pyrenomycete *Mondemartinia myriadea* gen. et. spec. nov. belonging to the Sphæriaceæ, Hyalodidymæ. A pycnidial form, *Coniothyrium* sp., was also diagnosed and a conidial stage referable to the genus *Ramularia*. Numerous chlamydospores were also formed in the cultures.

A. L. S.

Pathogenic Fungi on Tea.—MARIO CURZI ("De novis Thesæ Micromycetibus Pathogenis," *Ist. Bot. Univ. Pavia*, 1927, Ser. 3, 3, 59–72, 2 pls.). The author has determined and described seven new species of parasitic fungi on the leaves of the tea plants in the botanical garden at Pavia. They comprise two Pyrenomycetes, three Sphæropsidæ, and two Hyphomycetes. The most virulent parasite was *Phomopsis Theicola*, which attacked and destroyed leaves and branches. Curzi found, in addition, a considerable number of microfungi already described as living on tea in its native country.

A. L. S.

Hop Leaf-Spot.—H. WORMALD ("The Parasitism of the Hop Leaf-Spot Fungus *Cercospora cantuariensis*," *Trans. Brit. Mycol. Soc.*, 1928, 13, 32–9, 1 pl., 1 text-fig.). A description is given of the parasite and of the effects produced on the host leaves. A detailed account is here published of the infection of hop plants by the fungus grown on culture media. Conidia placed on leaves of hop plants in moist air produced in a few days the typical disease spots. Severe infection caused premature leaf fall.

A. L. S.

Botrytis Disease of Narcissus.—W. J. DOWSON ("On an Extraordinary Botrytis causing a Disease of Narcissus Leaves," *Trans. Brit. Mycol. Soc.*, 1928, 13, 95–102, 1 pl., 3 text-figs.). The name "fire" has been given to a disease caused by *Botrytis cinerea*, but that species is entirely different from the one studied by Dowson; it was found on narcissus plants in the wetter parts of the British Isles (S.W. England and N. Ireland). In the cultures conidiophores were formed with very large globose conidia in clusters at the tips, varying in diameter from 30μ to 50μ . On germination each conidium produced a number of germ tubes, hence the name of the new species *Botrytis polyblastis*. Successful inoculations of narcissus leaves were made with cultures of the large conidia. They are found only on dead leaves, the conidiophores emerging from the stomata. A. L. S.

Palm Leaf-Spot.—C. D. SHERBAKOFF ("Washingtonia Palm Leaf Spot due to *Cylindrocladium macrosporum* n.sp.," *Phytopathology*, 1928, 18, 219–25, 2 text-

figs.). The disease occurred in seedlings of *Washingtonia robusta* in Central Florida. The disease spreads rapidly and causes noticeable damage when there is abundant moisture present. The fungus was grown on various culture media, and the development is fully described. A species, *C. scoparium*, on roses, etc., is also described. A. L. S.

Penicillium Injury to Corn Seedlings.—HELEN JOHANN (*Phytopathology*, 1928, 28, 239–42). The fungus was detected during seed tests, and later was found to damage the seedlings. Infection took place in the embryo region and proceeded up the mesocotyl. The hyphae were both inter- and intra-cellular; the cells were apparently killed in advance by the mycelium. Some seedlings reached the fourth- or fifth-leaf stage before death occurred. A. L. S.

Action of Fungicides.—ZOFYA ZWEIFBAUMÓWNA (“Wpływ Arseninu sodu, sody oraz formaliny na krełkowaine zarodników maczniaków—L'influence de l'arsenite de soude, du carbonate de soude et de la formaline sur la germination des spores des Oïdiums,” *Acta Soc. Bot. Pol.*, 1926, 4, 1–10. Polish with French résumé). The purpose of the research was to test by laboratory methods the value of the several fungicides in destroying *Oidium* spores or in retarding their germination. The percentages of the various solutions employed are given, and the results obtained are set forth in a series of tables. It required 15 p.c. of arsenate and 10 p.c. of carbonate of soda to arrest germination entirely. The author found also that much depended on the maturity or age of the spores: the stronger the capacity for germination present in the spore, the less virulent was the effect of the poison. Formalin is volatile, and acted only feebly on the spores; it is not recommended as a fungicide. Carbonate of soda proved the most effective. A. L. S.

Intumescence on Peas.—MARIO CURZI and MARIA BARBAINI (“Intumescenze e Cladospori Pisi sui Legumi de Pisum sativum,” *Ist. Bot. Univ. Pavia*, 1927, Ser. 3, 3, 91–105, 1 pl.). The intumescence attributed to an infection by *Cladosporium Pisi* has been found by the authors to be a hypertrophy of the tissues due to defective transpiration. The authors describe the deformed tissues that had arisen, and the arrival of saprophytic fungi—*Rhizoctonia*, *Penicillium*, and others, with the always abundant *Cladosporium Pisi*, which was recognised as synonymous with *C. herbarum*. A. L. S.

Red Clover Anthracnose.—KATHLEEN SAMPSON (“Comparative Studies of *Kabatiella caulivora* (Kirchn.) Karak. and *Colletotrichum Trifolii* Bain and Essary, two Fungi which cause Red Clover Anthracnose,” *Trans. Brit. Mycol. Soc.*, 1928, 13, 103–42, 3 pls., 6 text-figs.). Four anthracnose diseases of Red Clover have been described as due to *Glæosporium Trifolii*, *G. caulivorum*, *Colletotrichum Trifolii* and *C. destructivum*. These different fungi have been confused or considered as synonyms. The object of the paper is to elucidate the synonymy. *Glæosporium caulivorum*, now known as *Kabatiella caulivora*, appeared at the Welsh Plant Breeding Station in 1920, and has been selected for study. Comparison has been made with *Colletotrichum Trifolii* from America. Both fungi have been elaborately studied from every point of view—their development, their morphology and physiology, and the effects produced on the host plants, also on the sources of infection. The writer found that the species were distinct, e.g., *Kabatiella* mycelium is almost entirely intercellular; in *Colletotrichum* it is largely intracellular. In both cases diseased plants developed from contaminated seeds. A. L. S.

Lichens.

Water Content of Lichens.—ALFRED HILITZER ("Reception et Evaporation de l'eau chez le Thalle des Lichens," *Bull. Intern. Acad. Sci. Bohême*, 1927, 1-19). The method of determining the amount of water absorbed is to weigh the thallus, and in doing so exactitude is more easily attained in the larger species, care being taken that no foreign bodies, such as earth or portions of other plants, are attached. A great deal depends on the humidity of the surrounding air. Calculations of the difference between dry and wet weight vary according to the lichen—very high in *Leptogium saturninum* and in gelatinous lichens generally, very low in *Dermatocarpon aquaticum*. He notes that the cortical structure is of chief importance; cavities and medullary tissues have no influence on the water capacity. The moisture is absorbed by the cellular membranes of the cortex and forms the reserve—very little enters into the protoplasm. The capacity of absorption varies considerably: in *Parmelia furfuracea* and *Usnea longissima*, "aerophil" species, it is high owing to the extended surfaces, filamentous or isidiose, which easily absorb from moist air. Absorption also goes on even in dry air. Loss of water is purely physical—by evaporation. The amount of evaporation in a given time has been calculated for a number of species, and the quickness of evaporation is an important ecological factor, as the thallus functions vitally only when sufficiently moist, and the condition as to saturation varies constantly. Hilitzer found that *Alectoria jubata* evaporated very quickly—in 30 minutes. In *Parmelia saxatilis* evaporation continued 16 hours. Aerophil species dry rapidly, and therefore a humid atmosphere is essential to their healthy growth. Hilitzer concludes, from his observations and calculations, that lichens have a water economy different from that of other plants: they are adapted to periodic drying up. The changes indicated concern mainly the cellular membranes, but the cell content of water must vary equally. In these respects mosses are most akin to lichens.

A. L. S.

Witch-Broom Formation in Lichens.—E. BACHMANN ("Hexenbesenbildung bei einer Strauchflechten," *Hedwigia*, 1926, 66, 331-6, 3 text-figs.). The abnormal growths on plants called witch-broom are due to an excitation of a fungus causing the host plant to form abnormal growths. Such a growth was detected on the lichen *Cetraria aculeata*, and has been traced by Bachmann to the attack of a parasitic fungus, *Sporotrichum Lettauianum* n. sp. Associated with this conidial stage he found pycnidia of *Coniothyrium imbricariae*. The fungus differs from the usual type of lichen parasite in that it induces abnormal dense branching of the host. It begins by attacking the algal cells, using up their contents, and finally destroys the algal cell walls and medullary hyphae of the *Cetraria*. A full description of the fungus is given and its effect on the lichen. It was collected by G. Lettau on sandy soil at Lorrach, in Baden.

A. L. S.

Lichenological Notes. III.—W. WATSON (*Journ. Bot.*, 1928, 66, 17-21, 1 text-fig.). Watson has contributed a series of notes on the occurrence and distribution of somewhat rare British lichens. He has added several species and varieties to the flora, and one species new to science, *Staurothela innata*.

A. L. S.

Lichens: with Notes on Local Species.—JAMES MENZIES (*Trans. Perthshire Soc. Nat. Sci.*, 1926-7, 8, 157-73). The author gives a general account of these plants in Perthshire, indicating the habitats and localities of some of the commoner species. He instances the occurrence on a patch of burnt soil of a species with small

foliaceous fronds that produced conidia but no fruiting bodies. The following summer its place was taken by *Peltigera spuria*, "a lichen not seen in the locality before and probably rare in Perthshire." A. L. S.

Study of Peltigera.—V. GYELNIK ("Peltigera-tanulmányok," *Bot. Közlem.*, 1927, 24, 122–40, 4 figs. Hungarian with German *résumé* in *tom. cit. Mit. für das Ausland*, 33–8). The author gives comparative morphological characters of a number of species, with a detailed account of seven species with varieties characterised by the presence of isidia, five of them new species. In the *résumé* he confines himself to an account of the various isidial forms and their occurrence. Another section of the work deals with three species that are sorediate at the margin; these are *Peltigera Nylanderi* n. sp., *P. scutata*, with two varieties, and *P. subscutata* n. sp., the latter from Pacific Beach, Washington. A. L. S.

Notes on Japanese Peltigerae.—V. GYELNIK ("Néhány Peltigera-adat Japánból," *Magyar Bot. Lapok* (1926), 1927, 25, 252–4). In a short German *résumé* the author reports that he found in the Vienna Museum a small collection made by Abbé Faurie. On examination he published *Peltigera variolosa* comb. nov., *P. Degani* n. sp., *P. subcamina* n. sp. and *P. Szatalae* n. sp. Descriptions of these are given. A. L. S.

Morocco Lichens.—JACQUES MAHEU and ABEL GILLET ("Deuxième Contribution à l'étude des Lichens du Maroc," *Bull. Soc. Bot., France*, 1925, 72, 858–70). The first contribution was published in *Compte-rendu de la Session du Maroc* 1921. The species now enumerated were collected near to Casablanca and at Tangiers. Several new species are described. A. L. S.

Corsican Lichens.—HERMANN ZSCHACKE ("Korsische Flechten, gesammelt in den Jahren 1914–16," *Verhandl. Bot. Ver. Brandenburg*, 1927, 69, 1–29). The author was collecting in Corsica in 1914, and had already dispatched the larger part of his material when war broke out and the specimens were held up at Dijon, remaining untouched for years. Maheu and Gillet finally took possession and described the species. The lichens of this paper had been sent by other routes or were collected by Zschacke during his detention as war prisoner. They give a fair representation of the Corsican lichen-flora, including 204 species, 18 of which are new to science. These are fully described. References and localities, with occasional notes, are given for the lichens already known. A. L. S.

Study of Lichen Gonidia.—E. J. FRY ("The Penetration of Lichen Gonidia by the Fungal Constituent," *Ann. Bot.*, 1928, 43, 141–8, 6 text-figs.). The relation between the alga and the fungus in the lichen thallus has been a much debated question. In her study of the subject Fry selected a crustaceous lichen, *Lecania cardicans*. She explains her methods of preparation and staining. She has definitely proved that the relationship between the two constituents in this lichen is one of parasitism of the fungus on the alga. The hypha lying alongside the gonidium sends out a slender haustorium which, by mechanical action, pierces the wall of the alga and swells out when within. She has found that daughter gonidia may be penetrated while still within the mother-cell. The empty gonidial envelopes lie mainly in the upper cortical region and are gradually discarded during exfoliation of the cortex. Fry considers that the gonidia persist until they are drained of their contents by haustorial development and succumb to the parasitic attack. She does not consider that all lichens are alike in the matter of symbiosis or parasitism. A. L. S.

Purple Bacteria of Chiodecton.—KARL SUESSENGUTH ("Zur Frage der Veegesellschaftung von Flechten mit Purpurbakterien," *Ber. Deutsch. Bot. Gesell.*, 1926, **44**, 573–8). The author considers that the colour-bacteria found by Uphof in his cultures of *Chiodecton sanguineum* had no relation to the lichen, and are not to be regarded as symbionts. Many tests were made as to the comparative reactions of the lichen granules and of the bacteria colour product. The properties of the lichen acid Chiodektin are described. The author was successful in obtaining it in crystalline form. Tests were also made by spectrum analysis which proved further the difference between the bacteria colour and the lichen acid. A. L. S.

Respiration of Plants.—JOAN FRAYMOUTH ("The Moisture Relations of Terrestrial Algæ. III. The Respiration of certain Lower Plants, including Terrestrial Algæ, with Special Reference to the Influence of Drought," *Ann. Bot.*, 1928, **42**, 75–100, 6 text-figs.). Experiments were made by the author on the lichen *Parmelia physodes*, either with the whole plant or with the tips of the fronds. It was found that the plant area whence the tested material was taken did not affect the result. It was found that respiration increased slightly up to 70 p.c. of water content, and more rapidly up to about 200 p.c. Beyond that it did not increase, and it was concluded that probably a film of water interfered with the gaseous exchange. The lichen gonidium was considerably less capable of responding to drought conditions than the same alga in a free condition. The lichen was tested also by severe artificial drought, and respiration was very slight. On the addition of water it became normal. A. L. S.

Hungarian Lichens.—ÖDÖN SZATALA ("A Magyarországi Coniocarpinæ-Kritikai Feldolgozása. Revisio critica Coniocarpinearum Hungariæ," *Ann. Mus. Nat. Hung.*, 1926, **24**, 99–135). In the introduction Szatala gives a history of the Hungarian records, dating from Wahlenberg in 1814, and scattered through more recent literature. The lichens themselves were also carefully sought out in the various herbaria and critically examined. The result has been to establish in the lichen flora of Hungary 40 species and 38 forms. Full references and in some instances descriptions of species are given. A. L. S.

Lichenes Hungariæ.—ÖDÖN SZATALA ("I. Pyrenocarpeæ-Gymnocarpeæ (Coniocarpinæ) Magyarország zúznióflórája," *Folia Cryptogamica* (Szeged, Hungary), 1927, **1**, 338–434. Hungarian with German Introduction). Szatala has given here the first instalment of a lichen-flora for Hungary. The present list includes 250 species, with references, localities, and habitat. He also gives a list of literature bearing on Hungarian lichens of 120 numbers. A. L. S.

Mycetozoa.

Montana Mycetozoa.—PAUL W. GRAFF ("Contributions to Our Knowledge of Western Montana Fungi. I. Myxomycetes," *Mycologia*, 1928, **20**, 101–13). The writer gives a record of 36 species, the first list of Mycetozoa from the State. He finds the time limited in which these organisms can be found. Until well into spring the temperature is too cool, but from the middle of May to the same time in June they are to be found. Growth ceases during the hot dry summer, then the Mycetozoa reappear again in the autumn. Various biological notes are given. A. L. S.

TECHNICAL MICROSCOPY.

An Ultramicroscopical Method for Estimating the Charge on Colloidal Particles.—P. TUORILA (*Kolloid Zeit.*, 1928, 44, 11). A method for the quantitative estimation of velocity of colloidal particles in an electric field is described. Measurements are made by direct observation of the particles with a slit ultra-microscope, a very suitable type of cell for the purpose being described. Smoluchowski's formula for the electroendosmotic streaming velocity of a liquid in a cell of rectangular cross-section has been tested with experimental data obtained and found to be valid.

W. J. E.

A Method for Cataphoresis Measurement in Suspensoids.—H. R. KRUYT and P. C. VAN DER WILLIGEN (*Kolloid Zeit.*, 1928, 44, 22). Macroscopical methods for estimating cataphoretic velocity are discussed and the various errors liable in measurements with colloids indicated. It is essential to have the sol supercharged with intermicellar fluid. An improved form of Burton apparatus is described in which disturbances caused by the accumulation of products of electrolysis at electrodes are eliminated and the potential gradient is known exactly. Microscopical methods are considered and a suitable form of cell described.

W. J. E.

The Action of Ultra-Violet Light on Some Colloidal Dispersions of Gold.—J. J. BEAVER and R. H. MULLER (*J. Am. Chem. Soc.*, 1928, 50, 304). The reaction of gold sols when exposed to ultra-violet light depends largely upon their nature and method of preparation. Sols which are sensitive to ultra-violet light become blue during the initial period of exposure, indicating a coagulation tendency, but continued irradiation results in the subsequent peptisation of the unstable blue sol to give a red sol identical with the original. An explanation of the phenomenon is given in terms of Wilson's conception of the structure of the colloidal gold particle. The various physical and photo-chemical properties of chemically prepared gold sols are found to vary continuously with the pH of the reduction mixture used. However, gold sols made by the Bredig method are uniformly stable to ultra-violet light, and the rate of precipitation of such sols is not influenced at all by irradiation.

W. J. E.

Artificial Silk Fibres, Microscopical Examination of.—L. G. LAWRIE (*J. Soc. Dyers Cols.*, 1928, 44, 73-8). For the satisfactory microscopical examination of artificial silk fibres, great care is required in preparation and mounting. The fibres are first dehydrated in alcohol solutions of increasing strengths, e.g. 25 p.c., 50 p.c., 75 p.c., 100 p.c. alcohol, remaining in the first three solutions for two hours and in the absolute alcohol for four hours or longer. The specimen is then cleared in oil of cloves and xylol, cedarwood oil, eucalyptus fluid (bergamot and cedar oils with carbolic acid), or with synthetic oil of wintergreen. For mounting, either euparal or glycerine jelly is favoured, but not Canada balsam. Media with high refractive indices, such as styrae or monobromo naphthalene, can also be used. Glare, due to the transparent nature of the fibres, can be reduced by partly closing the iris diaphragm on the substage, or the lamp may be fitted with a similar diaphragm. The author gives the characteristics of several artificial silks under polarised light. For the preparation of cross-sections, the silk fibre is wrapped on a wire frame and immersed for half an hour in a solution of celloidin in equal parts of alcohol and ether. On removal, the celloidin is coagulated by chloroform

or by air drying. Another method is to impregnate the fibres with a solution of $47\frac{1}{2}$ parts gum arabic in $47\frac{1}{2}$ parts of water to which is added five parts of glycerine. The fibres are subsequently dried in a warm air oven. When dry they are embedded in pith and cut either by hand or microtome (the Cambridge rocker cannot be used). Methods are also given for determining the swelling of fibres by water and caustic soda solution.

A. H.

Experiments in Ultra-Violet Refractometry.—L. C. MARTIN (*Trans. Opt. Soc.*, 1927–28, 29, No. 1). The experiments described have for their object the application of critical angle methods for the refractometry of liquids in the ultra-violet. A thin film of liquid can be held between two quartz hemispheres which are traversed centrally by an approximately parallel beam; the film receives the radiation at the varying angles of incidence resulting on rotation of the system. In this way, analysing the transmitted radiation with the aid of a quartz spectrograph, the critical angles for definite wave-lengths are measured, from which refractive indices can be calculated. The procedure necessary in seeking precise results is discussed, and a series of measurements on glycerine-water mixtures likely to be useful for immersion fluids in ultra-violet microscopy is given. A set of interesting phenomena of the extinction bands is described and explained.

NOTICES OF NEW BOOKS.

Seed Testing.—By JOHN STEWART REMINGTON. 1928. xi, 144 pp., 33 figs. Published by Sir Isaac Pitman & Sons, Ltd., 3 Parker Street, Kingsway, W.C.2. Price 10s. 6d.

Das Mikroskop.—By PAUL METZNER. 1928. xi, 509 pp., 372 text-figs. Published by Franz Deuticke, Wien und Leipzig. Price M. 38.60.

An Introduction to the Theory and Use of the Microscope.—By C. R. MARSHALL, M.A., M.D., LL.D., and H. D. Griffith, B.A. 1928. viii, 90 pp., 3 plates, 29 text-figs. Published by George Routledge & Sons, Ltd., Broadway House, 68–74 Carter Lane, E.C. Price 3s. 6d.

Microscope Record. No. 13. Jan. 1928. Published by W. Watson & Sons, Ltd., 313 High Holborn, London, W.C.1.

Microscope Record. No. 14. May, 1928. 31 pp. Published gratis by W. Watson & Sons, Ltd., 313, High Holborn, London, W.C. 1.

The Social World of the Ants.—By AUGUSTE FOREL. Translated by C. K. Ogden. 1928. Vol. I. xlv, 551 pp., 9 plates, 95 figs.; Vol. II. xx, 445 pp., 15 plates, 43 figs. Published by G. P. Putnam's Sons, Ltd., 24 Bedford Street, London, W.C.2. Price £3 3s. the set.

We are indebted to Mr. C. K. Ogden, the Editor of *Psyche*, for an admirable English translation of this magnificent work of Auguste Forel. The book is beautifully produced, and the many text-figures and coloured plates are of a high standard of excellence. The work is in two volumes. Vol I: Part I is concerned with the phylogeny, entogeny, and polymorphism of ants; their external and internal anatomy; and the classification of ants. Part II deals with the sensations, physiology, and psychology of ants; ants and ant plants; the animal guests of ants; parasites, toxicology, and ant monstrosities, and ant-nests. Part III of the same volume describes the observation apparatus and expeditions; the nuptials of ants and the

formation of colonies; ant-life inside the nest; the art of nest-building; ant-cattle and their food; ant-gardens; and the mutual parasitism of ants. Vol. II: Part IV deals with alliances between ants; the experiments of Miss Adele Fielde; ordinary wars among ants; wars between ants and other live creatures, and Nature; parabiosis, lestobiosis, and cleptobiosis in ants; and slave-making ants. The final part, Part V, is devoted to the wars of the visiting ants; the granaries of the harvesting ants; the mushroom-growing ants; weaving ants; ants-janitors; the *Rhagomyrmecinae*, etc. A stimulating Epilogue by Forel, and an Appendix entitled "War between the Ants and the Termites—A Study of the Origin of Instinct," by Professor E. Bugnion, conclude a book which is both an example of the highest scientific achievement and a delight to read. Forel, with his professed aversion to the sham of decking ignorance in impressive verbal garments, takes up his pen with a simple and inspiring vigour that carries his "dear readers" from start to finish in entranced companionship. It is seldom one comes across a book at once so scientific and at the same time so simple that scientist and layman alike can share in following all that is told. Most of us are already aware of a few of the claims to "greatness" held by the ants. Forel considers that what we term "blind instinct," illuminated here and there by a flash of intelligence, directs the lives of these remarkable creatures. The occasional flashes of intelligence which lead to the acquirement of habits, accumulate as hereditary race-memory and unconsciously directs the way of the ant. Man will concede much that he shares with other animals—a similar muscular and nervous mechanism, sight, taste, hearing, fear and rage—but no baron ever more jealously guarded his right than Man his claim that he alone of all the animals can boast intelligence. Yet Forel, in his Epilogue, advocates an International Parabiosis of the Nations of the World, copying to some extent the example of the ants. As he says, "But long before any of us, the ants had realised the true universal fraternity in equality and liberty in the form of parabiosis for communal work. Work in the midst of general peace is the true liberty. . . . The reign of idleness and its privileges must cease, for at all times and in all places they lead to degeneracy in the individual, as with the 'rois fainéants,' or in the race, as with *Strongylognathus testaceus*, and finally *Anergates*."

But the way to universal peace and goodwill among men, essential as it is now if Man is not to fail in the proof of his intelligence, can only, in part, be studied in the ways of the ants. The exemplary parabiosis among certain ants which leads to the natural and free social relations between two or more species, each keeping its apartments and brood separate from one another, yet going out as friends in common files for the task of maintaining their duties and existence, meets a terrible contrast in the lestobiosis and cleptobiosis adopted by other species. Lestobiosis, as so interestingly described and defined by Forel in Vol. II, is nothing short of the foulest murder, and cleptobiosis simply highway robbery often with violence. What a conglomeration of principles! Parabiosis, lestobiosis, cleptobiosis, slavery, and unselfish ingenious industry is spread before us in "The Social World of the Ants." The book is certain to find an instant welcome in the English-speaking world, and will captivate the interest of its readers.

M. E. M.

The Species Problem.—By G. C. ROBSON. 1928. vii, 283 pp. Medium 8vo. Oliver & Boyd, Tweeddale Court, Edinburgh. Price 15s.

Mr. Robson has brought together a fine collection of the opinions of the newer lights on the subject of the nature and origin of specific differentiation in animals and plants. Varied in quality as the materials are, he has contrived to work them into a logical sequence.

It is hard to decide what a species is, and yet everyone who gives a new name ought to have some idea of the amount of difference that matters, if only to prevent him from bestowing names lightly, unadvisedly, and wantonly. It is a mere evasion to say that "the individual is of more consequence than the species," though this is, perhaps, the most widely held of all beliefs. To say that "specificity is an universal attribute of organised life" is only to take shelter behind the abstraction of an abstraction. "The groups which the systematist treats as species have a tolerable degree of homogeneity" is damningly faint praise for the systematist, and, besides, it obliges us to define him. If we further concede to Mr. Robson that "the systematic status of such groups is a purely conventional matter," then *solvantur tabulæ risu*—there is no species problem. It is plain that all theories which appeal to a pious belief in "first parents" must bring us to a dead end; they may be true, but they can never be tested. Darwin was very wise when he wrote that no clear line has as yet been drawn between species and varieties, and added that to make the distinction he fell back upon the opinions of naturalists having sound judgment and wide experience—magi, indeed. In practice "characters" form the criterion. This elastic word covers all that we can make out concerning the animal or plant under consideration. "It may be any part or parts of the structure, the physiological activities, the habits, food, distribution—in short, any of the ways in which an organism impresses itself upon our notice." Scientific usage sometimes blurs the meaning of a word instead of making it more precise and exact; for "character" really means something plainly engraved upon an object, such as the number of miles on a milestone. The older naturalists believed in "characters" of this sort—stigmata, in fact. A certain butterfly has brown tips to its antennæ; the allied species has black tips. You examine the antennæ, and infallibly decide to which species your specimen belongs. In many cases it took a very clever man to discover the distinction, but, once discovered, anyone could apply it. In practice the scheme is marvellously successful. It is not pretended that there is anything scientific about the discovery of these characters; to find them out requires powers of acute observation; to apply them only calls for the possession of the requisite knowledge. British lepidoptera and coleoptera have been well worked out, and the distinctions between species are not often nebulous. In the case of other orders, some difficulty arises in consequence of the existence of treatises written before their authors knew the subject well enough; such books only obscure knowledge. When we pass to foreign forms, there is in some genera a considerable want of well-defined distinction between the species; but there is little doubt that this is due chiefly to assiduous species-making. Our method of cataloguing does not take account of the fact that a form may be fully differentiated in one part of the world, but not in another, a fact with which our naming system is unable to cope. Incomplete specific differentiation is a much rarer thing in Nature than some modern biologists seem to think.

The criterion here attributed to Huxley, which depends upon the infertility of hybrids, is treated very fully. Having regard to the great variation of the accessory organs of generation in lepidoptera, we can hardly doubt that they form a factor in the isolation of species from one another. It is quite to be expected that so elaborate a method should occasionally break down, and it is well known that this is the case. But it is important not to lay too much stress upon negative evidence in this matter. The art of keeping animals in captivity is not uniformly distributed among naturalists, as the experimental guinea-pig knows well. The rearing of mollusca from the egg may be a fairly simple matter in some cases, but even in these not all experimenters are equally successful.

The chapter on isolation as a factor in the divergence of species is perhaps the best in this most interesting book. The footnote with which it concludes forms an excellent comment upon the present state of knowledge of the whole matter. Few writers seem to realise how large a body of experimental and observational records is required to make sure of the simplest things.

We could wish for rather more detailed citation of the works referred to in the course of this book. The bibliography exhibits an immense range of literature over which we have to travel in order to find the key to some of Mr. Robson's allusions. It is essential to find out exactly what each research is about and what conclusions were reached. We are not often told in the text, and need, therefore, to refer to the original papers. Few people are in a position to do it; the library of the R.M.S. would take them but a very little way. This is probably the reason why so many competent naturalists seem to stand outside studies of this kind. Occasionally it may be necessary to read a whole paper in order to ascertain the meaning of a single sentence; such papers are ill-served by the method of citation. This may be due to the avoiding of philological studies by some modern men of science. It may be true, for instance, that "spatial isolation prevents organisms from crossing only when isolated in space" (p. 133), but we think that the authority quoted might have expressed his thought more plainly.

But we congratulate Mr. Robson upon his achievement. He has summarised a large amount of recent work in a form which makes it accessible, and this is a great thing to do.

E. W. B.

Macrophotographie et Microphotographie.—By F. MONPILLARD. 1926. xxxi, 671 pp., 86 text-figs. Published by Gaston Doin et Cie., 8 Place de l'Odéon Paris (VI^e). Price 25 fr.

The extent to which photography has been applied to the representation of objects of scientific interest, either with or without magnification, is well indicated by the range of this interesting work, which in itself is one volume of a "Library of Photography," issued under the direction of Mr. A. Seyewetz.

In the Preface the author attractively outlines the historical development of photography, of the optics of photography, and of the microscope.

The book contains twenty chapters and 671 pages, and includes a useful bibliography.

The apparatus and technique of macrophotography, applicable to the purposes of scientific work, are first described, a chapter being devoted to photography in colour.

Microphotography is taken up in Chapter VI, and various chapters following are devoted to sources of light, systems of illumination, microscopes and apparatus, objectives and oculars, and the actual technique of microphotography.

The use of polarised light, microspectrography, metallography, instantaneous and cinematographic microphotography, work with ultra-violet light, stereoscopy and radiography, are separately discussed.

The illustrations are not very numerous, but the book is written in a readable style in which the scientific principles as well as descriptive matter are attractively presented.

Obviously, much of the general discussion and technique is common to many or all of the special applications, so that the book should be useful to all who may be called upon to work in any portion of this wide field.

The use of the word "photograph," prefaced by "macro," or "micro," instead of "photomicrograph," is justified by the author on the authority of a resolution of the Congress of Photography of 1889. The alternative method, however, seems more logical.

Bolles Lee's Microtometist's Vade-Mecum.—Edited by J. BRONTË GATENBY, and E. V. COWDRY. Ninth Edition. 1928. x, 714 pp., 9 text-figs. Published by J. & A. Churchill, 40 Gloucester Place, Portman Square, W.1. Price 30s.

The latest addition of "The Vade-Mecum" appears under the joint editorship of Professor J. Brontë Gatenby and Dr. E. V. Cowdry, of the Rockefeller Institute, New York. Two entirely new sections have been added: one, by Dr. Robert Chambers, on micro-manipulative technique; the other, by Dr. W. R. G. Atkins, on the histological applications of measurements of acidity, alkalinity, oxidation and reduction. The protozoological section has been entirely rewritten and enlarged, while the embryological, cytological and entomological sections have also been enlarged.

Despite excision and the use of smaller type for some matter, the present edition has 116 more pages than the eighth.

There are occasional typographical errors, e.g. on p. 381 "Carvel" for "Carrel." It also seems desirable that some uniform method of giving references should be adopted. On p. 390 a reference in the *Anatomical Record* is given as "28, 371, 1924," while on p. 391 a reference from the same journal is recorded as "xi, 1908, p. 207."

In view of the increasing importance of the specific cell inclusions associated with many ultra-microscopic viruses, it would be an advantage if a short section could be inserted dealing with methods for demonstrating these virus inclusions.

G. M. F.

The Microscope, Origin and Development of, as illustrated by Catalogues of the Instruments and Accessories in the Collections of the Royal Microscopical Society, together with Bibliographies of Original Authorities. Edited by ALFRED N. DISNEY, M.A., B.Sc., F.R.M.S., in collaboration with CYRIL F. HILL, M.Inst.M.M., A.Inst.P., F.R.M.S., and WILFRED E. WATSON BAKER, A.Inst.P., F.R.M.S. xi, 303 pp., 30 plates, 36 text-figs. Published by the Royal Microscopical Society, 20, Hanover Square, London, W.1. Price 17s. 6d. net. Price to Fellows only (one copy each), 15s. net. Postage 9d.

Die Geschlechtschromosomen.—By FRANZ SCHRADER. 194 pp., 43 text-figs. Published by Verlag von Gebrüden Borntraeger. Berlin, 1928. (English Edition).

Since 1901, when McClung first communicated the sex-chromosome theory of sex determination, a vast and rapidly increasing literature on the subject has been accumulating. This literature has dealt mainly with two chief aspects of the problem: the cytology of the sex-chromosomes and the inheritance of sex-linked characters. Our knowledge of both these subjects has long since attained to a state requiring a full and critical survey of the work in a convenient form. The more general aspects of both lines of work have been ably treated in such works as that of Wilson in "The Cell in Development and Heredity," but no complete account of either line has been available in English. The present book meets this need, so far as the cytology of the sex-chromosomes is concerned, and the reviewer hopes that as good an account of sex-linked inheritance will be forthcoming.

Dr. Schrader's book may be divided into two parts: the first, covering about one-third of the whole, deals with the theoretical and historical considerations, and includes sections on Nomenclature, Heteropycnoasis, Precession and Succession, the theories of Sex Determination, etc. The remaining two-thirds of the book is

a systematic review of the sex-chromosomes in the different groups, and deals in a remarkably complete manner with the literature. The book is much enhanced by good and copious text-figures and tabular presentations of results. A bibliography containing about six hundred references adds materially to its value. The clear and concise style in which it is written and the amazing amount of ground which it covers render the book both interesting to read and invaluable for reference. It is distinctly stimulating and worthy of a place on the shelves of every biological library.

F. W. R. B.

Asilidæ of France.—E. SEGUY, "Faune de France, 17, *Diptères (Brachycères), Asilidæ*." Office Central de Faunistique, 190 pp., 384 text-figs. Published by P. Lechevalier, Paris. Price 35 fr.

In this important work, comprising 190 pages, the author, in his introduction, pp. 1-10, gives an interesting and concise account of the general characters of the *Asilidæ*, together with a description of the morphology and anatomy of the eggs, larvæ, pupæ and adults, supported by excellent figures. A section of the introduction is devoted also to the bionomics and natural enemies of the *Asilidæ*. The author states that the proboscides of the larger species are able to pierce even the hardest chitin of such insects as the *Coleoptera*, and that the salivary fluid injected into the prey brings about its death or complete paralysis immediately. Most of the victims of the *Asilidæ* are said to be killed in this way instantaneously. The blood and body-fluids of the victim are first aspirated by the proboscis and later a digestive secretion produced by the thoracic glands is pumped into the body of the victim, resulting in the dissolution of the internal organs, which in turn are aspirated subsequently by the proboscis. The time taken in the process ranges from about a minute for small insects to an hour or more for larger prey. The *Asilidæ* are said to be insatiable; as soon as one insect has been captured and consumed, another is caught and devoured. The author states that the chief natural enemies of the *Asilidæ* are fungoid parasites (*Empusa*, etc.), species of *Trombidium*, birds and spiders. Copulation takes place on warm sunlit days; the act is often performed in flight, or the female may settle on herbage while the male hangs suspended from the terminal end of the abdomen of its mate. During copulation the female has been observed to feed on a captured insect, and at times she has been observed to turn and consume her partner after fertilisation has been effected. The remainder of the book is devoted to a full description of a large number of genera and species of the following four sub-families—*Leprogasterinæ*, *Asilinæ*, *Laphriinæ*, *Dasypogoninæ*. Numerous keys are provided for the specific identification of specimens, and the associated illustrations are all of a high order of excellence.

M. E. M.

Synopsis of North American Diatomaceæ.—Part II. Coscinodiscatæ, Rhizosolenatæ, Biddulphiatæ, 228 pp. Part II. Naviculatæ, Surirellatæ, 356 pp. By CHARLES S. BOYER, A.M., F.R.M.S. *Proceedings of the Academy of Natural Sciences of Philadelphia*, Supplements to Vol. LXXVIII (1926) and Vol. LXXIX (1927).

The recent death of C. S. Boyer, of Philadelphia, involves the loss of a very earnest and conscientious worker on Diatoms. There is no doubt that his *Synopsis* is the most comprehensive and outstanding work on this subject which has been published in the English language for very many years. Upwards of nineteen hundred species and varieties are here recorded, "but this number will be considerably increased when more extensive collections are made in the southern and western parts of the continent."

The Synopsis deals entirely with recent forms from North America and the West Indies, no reference whatever being made to fossil forms, and, unfortunately, the work is entirely destitute of figures.

In a short introduction of thirteen pages there are notes on the Macroscopic Appearance, Microscopic Appearance, Cell Contents, Cell Division, Reproduction, Movements, and Distribution of Diatoms.

One hundred and eighteen Genera are dealt with, and the keys to the species of the various genera will be found very helpful. *Lysigonium* and *Gaillonella*, which the author accepted in his earlier work ("The Diatomaceæ of Philadelphia and Vicinity," Lippincott, 1916) are now abandoned. With regard to nomenclature, the author presses strongly for strict priority, but whether all his ideas will be generally accepted by diatomists is doubtful. For example, the well-known and generally accepted name *Biddulphia pulchella* Gray, 1821, must now be given up in favour of *Biddulphia biddulphiana* (Smith) Boyer, 1901, the earliest name of the form being *Conferva Biddulphiana* Smith, 1807. This is one of many instances.

Another innovation of doubtful value is the agreement in gender of varietal names with the specific name, instead of the varietal name always being feminine to agree with "varietas." Thus we have here *Coscinodiscus radiatus medius* instead of the usual form *Coscinodiscus radiatus* var. *media*.

These, however, are points of minor importance, and there is no doubt that diatomists will heartily welcome the appearance of the Synopsis. What a pity it is that the author has not lived to deal in a similar manner with the fossil diatoms of North America.

J. A. L.

The Structure of an Organic Crystal.—By Sir WILLIAM H. BRAGG, K.B.E., F.R.S., M.A., D.Sc. Fison Memorial Lecture, 1928. 32 pp., 10 figs. Published by Longmans, Green & Co., Ltd., 39 Paternoster Row, London, E.C.4. Price 1s. 6d.

The publication of this lecture in booklet form provides an interesting account of organic crystal structure for readers with scientific interests. It does not appeal particularly to microscopists, as the subject is essentially physical or chemical. It has, however, a very definite relation to biology, and it is in this connection that it may ultimately have a wide application, particularly when radiations other than visual light become more widely used. The lecture is characterised by that remarkable lucidity that has come to be associated with the name of the author.

J. E. B.

PROCEEDINGS OF THE SOCIETY.

AN ORDINARY MEETING

OF THE SOCIETY WAS HELD AT 20 HANOVER SQUARE, W.1, ON WEDNESDAY, MARCH 21ST, 1928, MR. JOSEPH E. BARNARD, F.R.S., PRESIDENT, IN THE CHAIR.

The Minutes of the preceding Meeting were read, confirmed, and signed by the President.

New Fellows.—The following were balloted for and duly elected Ordinary Fellows of the Society :—

Alfred Samuel Chanter.
M. A. Fikry, B.A., B.Sc.
J. Walker Wood, L.R.C.P., L.R.C.S. Edin.

New Honorary Fellow :—

Sir Edwin Ray Lankester, K.C.B., M.A., LL.D., F.R.S., etc., etc., was duly elected an Honorary Fellow of the Society.

Donations were reported from :

Sir Isaac Pitman & Sons, Ltd.—
“Seed Testing.” (Remington.)
Messrs. J. & A. Churchill—
Bolles Lee’s “Microtomist’s Vade-Mecum.” (J. Brontë Gatenby.)
Messrs. Franz Deuticke—
“Das Mikroskop.” (Metzner.)
Messrs. Longmans, Green & Co., Ltd.—
“Structure of an Organic Crystal.” (Bragg.)
Dr. O. F. Blankingship—
Quantity of Diatomaceous Earth from Richmond, Virginia.
Mr. C. D. Soar, F.L.S., F.R.M.S.—
A Benjamin Martin Microscope and Accessories in Case.

Votes of thanks were accorded to the donors.

The Treasurer presented the Balance Sheet and Financial Report for the year 1927.

FINANCIAL REPORT FOR THE YEAR 1927.

The Income and Expenditure Account for the year shows a balance of Expenditure over Income of £479 1s. 7d.

This amount, less the credit balance of £374 16s. 6d. brought forward, leaves a balance of £104 5s. 1d to the debit of Accumulated Income and Expenditure Account.

There is no change in the Life Membership Account, which stands at £1,884 10s.

Turning to the Investment Account, it will be noticed that investments have been increased by £198—to £1,969 10s. 5d., the market valuation at 31st December, 1927, being £2,309 11s. 1d.

A bequest of £45 from the late Mr. H. H. Mortimer has been received and credited to the Capital Account.

Sales of surplus books and periodicals from the Library realised £59, and this amount has been credited to Capital Account. This year the sum of £34 has been spent on the Library, but there is still much to be done to make up arrears of binding, and a new Library Catalogue is contemplated.

Compared with a year ago, all items of income show a decrease, which in the aggregate is £58, whilst expenditure shows a considerable increase owing to the increased net cost of the Journal, due to the change of format causing an increase on all items of expenditure in cost of publishing.

On the credit side the Council has had to reserve £150 for a doubtful debt.

It is hoped that this year the improvements in the Journal will result in an increased number of subscribers, and in this connection the Society has made arrangements whereby the bulk of this work will be done from the Office instead of through Agents.

The number of Fellows on the Roll of the Society on 31st December, 1927, was 513, a decrease of 47 compared with the same date 1926, made up as follows :—

Number of Fellows on the Roll of the Society at		
31st December, 1926		539
Ordinary Fellows elected during year		21
		560
Resigned or removed during year	35	
Deceased during year	12	
	—	47
At 31st December, 1927		513
This total is made up of—		
(a) Ordinary Fellows	467	
(b) Life	32	
(c) Honorary	14	
	—	513

It is important to emphasise the desirability of Fellows bringing to the notice of suitable candidates the aims and objects of the Society in order that the number of Fellows on the Roll may not only be maintained, but increased.

Dr.

INCOME AND EXPENDITURE ACCOUNT.

Dec. 31, 1928.	£	s.	d.		£	s.	d.	£	s.	d.
163	16	0		To Rent, Lighting, Heating and Insurance .				177	8	3
430	0	10		„ Salaries and Reporting				520	4	9
				„ Sundry Expenses—						
				Library Books and Binding	34	1	2			
				Stationery and Printing	52	5	10			
				Postages and Petty Expenses	47	10	6			
				Repairs and Renewals	26	16	4			
170	8	0		Refreshments at Meetings	6	4	1			
				„ Journal—				166	17	11
				Expenditure—	£	s.	d.			
				Printing	763	1	4			
				Editing and Abstracting	69	2	0			
				Illustrating	111	3	9			
				Postages	30	4	10			
				Less Receipts—				973	11	11
				Sales	402	1	5			
				Advertisements	111	12	5			
				Deduct—	513	13	10			
				Reserve for Doubtful Debts	150	18	5			
32	6	10						362	15	5
				„ Liverpool Conference				610	16	6
268	6	1		„ Balance, being Excess of Income over Expenditure				10	2	1
								—	—	—
<u>£1064</u>	<u>17</u>	<u>9</u>						<u>£1485</u>	<u>9</u>	<u>6</u>

Dr.

BALANCE SHEET AS AT

	LIABILITIES.	£	s.	d.	£	s.	d.
I. Capital—							
Being (a) Life Compounded Subscriptions received from 1st January, 1877, to 31st December, 1927		1884	10	0			
(b) Quekett Memorial Fund		100	0	0			
(c) Mortimer Bequest		45	0	0			
(d) Amounts received in respect of sales of Books from the Library (surplus to the Society's requirements)		188	12	0			
					2218	2	0
II. Loan Account					200	0	0
Note.—The Hon. Treasurer of the Society has advanced this sum and has undertaken to advance any additional sums that may be required to meet the cost of publishing the catalogue of Instruments. The loan is made to the Society free of interest.							
III. Sundry Creditors—							
Subscriptions paid in Advance		15	19	2			
Journal Subscriptions paid in advance		64	1	2			
On account of Journal Printing, etc.		511	18	4			
					591	18	8

£3010 0 8

London, 24th February, 1928. We have examined the Books and Accounts of the Royal Microscopical Society for the year to 31st December, 1927, and have found the transactions correctly recorded and sufficiently vouched.

In our opinion the foregoing Balance Sheet is properly drawn up so as to exhibit

CYRIL F. HILL,

Hon. Treasurer.

FOR YEAR TO 31st DECEMBER, 1927.

Cr.

Dec. 31, 1926.

£	s.	d.		£	s.	d.	£	s.	d.
889	11	10	By Subscriptions	769	10	10			
			„ Subscriptions for 1927 unpaid	87	8	0			
60	18	0	„ Admission Fees				856	18	10
0	10	9	„ Sundry Sales				48	6	0
113	17	2	„ Interest on Investments and Deposit Account				11	3	
			„ Balance, being Excess of Expenditure over Income				100	11	10
							479	1	7

£1064 17 9

£1485 9 6

31st DECEMBER, 1927.

Cr.

	£	s.	d.	£	s.	d.
ASSETS.						
I. <i>Furniture, Instruments, etc.</i> , as at 31st December, 1926.	216	13	6			
Additions during year	18	1	8			
				234	15	2
II. <i>Stock of Screw Gauges</i> as at 31st December, 1926				2	0	0
III. <i>Investments</i>				1969	10	5
£400 London & North Eastern Railway Co. 3% Debenture Stock.						
£500 Nottingham Corporation 3% Irredeemable Debenture Stock.						
£915 11s. 4d. India 3% Debenture Stock.						
£150 Metropolitan Water Board "B" Stock.						
£612 London Midland & Scottish Railway Co. 4% Preference Stock.						
£200 New South Wales 5½%.						
£421 1s. 5% War Loan, 1929-47.						
IV. <i>Catalogues of Instruments</i> —Amounts expended on publication to date				162	12	5
Note.—The Hon. Treasurer of the Society has given his personal guarantee to meet any part of this expenditure that is not recovered by means of sales of the publication.						
V. <i>Sundry Debtors</i> —						
Subscriptions Unpaid	87	8	0			
On account of Journal Sales	267	7	9			
Less Reserve for Doubtful Debts	150	18	5			
	116	9	4			
On account of Advertisements, etc.	60	4	6			
VI. <i>Cash</i> —				264	1	10
At Bank—On Current Account	273	10	11			
Deduct Petty Cash due to Secretary	0	15	2			
VII. <i>Income and Expenditure Account</i> —				272	15	9
Being Excess of Expenditure over Income for year to 31st December, 1927	479	1	7			
Deduct : Excess of Income over Expenditure as at 31st December, 1926	374	16	6			
				104	5	1
				£3010	0	8

a true and correct view of the state of the Society's affairs, subject to it being noted that no account has been taken of the value of the Society's Library and Stock of Journals (valued for insurance, together with the Furniture, Instruments, etc., at £4,000).

(Signed) THOMSON McLINTOCK & CO.,

Chartered Accountants, Hon. Auditors.

71, Queen Street, E.C. 4.

Mr. Hill moved, and **Mr. Blood** seconded :—

“ That the Financial Report be received and adopted.”

Carried.

Mr. S. C. Akehurst moved, and **Mr. C. H. Caffyn** seconded :—

“ That a very hearty vote of thanks be accorded to Messrs. Thomson McLintock & Co., Chartered Accountants, for their services as Honorary Auditors to the Society.”

Carried unanimously.

The following papers were read and discussed :

Professor D. C. Blair, M.B., Ch.B.—

“ A Nerve Mechanism in the Capillaries of Muscle.”

Dr. James A. Murray, F.R.S., F.R.M.S.—

“ Contribution to the Study of Diatom Markings.”

Dr. G. S. Sansom, D.Sc., F.R.M.S.—

“ A Portable Microscope Table.”

Votes of thanks were accorded to the authors of the foregoing communications, and to Messrs. R. & J. Beck and Messrs E. Leitz & Co. for the loan of microscopes.

The business proceedings then terminated.

AN ORDINARY MEETING

OF THE SOCIETY WAS HELD AT 20 HANOVER SQUARE, W.1, ON WEDNESDAY, APRIL 18TH, 1928, MR. JOSEPH E. BARNARD, F.R.S., PRESIDENT, IN THE CHAIR.

The Minutes of the preceding Meeting were read, confirmed, and signed by the President.

The nomination certificates of the following candidates were read for the first time :—

William Hindle, Montreal.

Bertram Frederick Jearey, Cape Town.

Henry Rhodes, Halifax.

A Donation was reported from :—

Mr. J. E. Barnard, F.R.S., P.R.M.S.—
Roll top mahogany desk.

A vote of thanks was accorded to the donor.

The Deaths were reported of :—

Charles S. Boyer. Elected 1914.
Thomas B. Bradshaw. Elected 1918.
William Hartree. Elected 1867.
Edmund Maurice. Elected 1921.

Votes of condolence with the relatives were passed.

Exhibit.—Mr. D. J. Scourfield exhibited and described some oospores of *Volvox* sp. and a young cœnobium just hatched from one of them. He said that he had kept the oospores since last September, when they were being produced by a large proportion of the specimens of a species of *Volvox* which occurred at that time in great numbers in the Eagle Pond, Snarresbrook. As would be seen they were of a bright orange colour, and the spherical coat in which they were enclosed was quite smooth. They were therefore very similar to the oospores of *V. aurens*, but the *Volvox* in question differed from *V. aurens* and also from *V. globator* in that it had no protoplasmic connections between the cells. Young cœnobia had commenced to hatch out from some of the oospores about the beginning of March, and were continuing to do so, but there were still many oospores in their original condition. He had not yet been fortunate enough to watch the actual process in the case of these oospores, but he had seen a sufficient number of different stages to convince him that during development the young cœnobia turned inside out in exactly the same way as the daughter cœnobia did when developing within the mother cœnobium.

Replying to certain questions regarding the turning inside out of young *Volvox* cœnobia, Mr. Scourfield explained that this remarkable process took place in the following way: After the cell divisions had gone on for some time—probably, in fact, until the stage was reached when no further divisions were to take place—a little opening into the hollow ball of cells known as the phialopore commenced to expand. This continued until the rim of the phialopore actually turned out and over the sides of the ball, the appearance of the little cœnobium at this stage being comparable to a bowler hat, the brim of the hat being represented by the rim of the enormously expanded phialopore. This out-turned rim then slowly crept down and round the ball, bringing with it more and more of the interior to the outside. As it approached the opposite side of the ball from which it started, it gradually closed up again, while the part of the ball over which it was creeping bulged out in the opposite direction, thus completing the process of evagination. As the ends of the cells which had at first faced the interior came over the edge to the outside, they could be seen to be already provided with two little projections. These were the rudiments of the flagella, which, in a very short time, acquired considerable length and commenced to move slowly. The whole process of evagination lasted from two to four hours.

The following papers were read and discussed :—

Dr. K. F. Belar (Kaiser-Wilhelm Institute for Biology, Berlin).

“The Separation of Protoplasms in the Myxomycete *Didymium* by Stimuli.”

Mr. B. K. Johnson.

“Some Introductory Experiments dealing with a Quantitative Method of Determining the Resolving Power of Microscope Objectives.”

DISCUSSION.

Mr. Conrad Beck thought Mr. Johnson's method of testing objectives (see pp. 144–158) showed great ingenuity and appeared to be a novel way of attacking the problem. For the testing of lenses of low and moderate apertures it might be found to be superior to a series of different gratings.

As a manufacturer of lenses which were required to produce perfect images, and being constantly confronted with the difficulties which arose in achieving this, he was perhaps prejudiced against employing an image produced by a lens as a test object because of the imperfection of the image so obtained.

He said it was evident that the image must be produced by a lens of greater numerical aperture than the lens being tested, otherwise the lines of the grating might not exist in its image, and unless the numerical aperture of the image-forming lens were considerably greater than that of the lens being tested, the image might be an indefinite and fuzzy series of lines, because diffraction caused an image of a line to be band bright at its centre and fading away towards its edge.

For these reasons, while Mr. Johnson's method had valuable applications, a series of ruled gratings would, Mr. Beck thought, be more reliable. Unfortunately, no one at present had produced rulings finer than 120,000 lines to the inch, and these were not sufficiently fine to test modern high-power lenses.

Mr. Harold Wrighton suggested the use of lamellar pearlite as a test object in the measurement of resolving power. Almost any specimen of carbon steel in the forged or annealed condition showed, he said, in different fields, lamellæ varying from quite coarse, resolvable at low powers, to very fine, unresolvable by objectives using visual light.

Under proper conditions of illumination and suitable preparation of the specimen the lines were very sharply defined where resolved, and it was always possible, by a little searching, to find a patch of pearlite which the objective under test just failed to resolve clearly. A photograph of such a field would show the lamellæ in sufficient contrast to allow of their being counted.

Votes of thanks were accorded to the authors of the foregoing communications and to Mr. Scourfield for his exhibit.

The President announced that the Biological Section would meet in the Library on Wednesday, May 2nd, 1928, at 7.30 p.m.

The business proceedings then terminated.

AN ORDINARY MEETING

OF THE SOCIETY WAS HELD AT 20 HANOVER SQUARE, W.1, ON WEDNESDAY, MAY 16TH, 1928, MR. JOSEPH E. BARNARD, F.R.S., PRESIDENT, IN THE CHAIR.

The Minutes of the preceding Meeting were read, confirmed, and signed by the President.

New Fellows.—The following were balloted for and duly elected Ordinary Fellows of the Society :—

William Hindle.
Bertram Frederick Jearey.
Henry Rhodes.

The nomination certificates of the following candidates were read for the first time :—

Walter Martyn Else, Buxton.
F. W. Harris, Birmingham.
Sydney Gibson Laws, Uganda.
Edward G. T. Roberts, Launceston.
Albert Reginald Yarwood, Southport.

A Donation was reported from :—

Mr. Frederick Adams, M.Inst.C.E., F.R.M.S.—

£20 towards the cost of printing the "Index to the Diatomaceous References in the R.M.S. Journal 1853-1915."

A vote of thanks was accorded to the donor.

Exhibit.—Messrs. R. and J. Beck exhibited and described a new form of pathological microscope specially designed for the School of Tropical Medicine and Hygiene.

PAPER.

Dr. H. Moore, A.R.C.S., D.Sc., F.Inst.P., then read his paper on "The Mode of Formation of the Image in the Microscope" (see pp. 133-143).

DISCUSSION.

The President suggested that, owing to the shortness of time available that evening, any discussion of this important communication should be deferred to another evening, after the paper had been printed and published.

Sir Herbert Jackson, supporting the President's suggestion, thought that an inadequate discussion of the paper that evening would be undesirable, and agreed that, as the subject was a very important one to the Royal Microscopical Society and to microscopists generally, it was worthy of a full discussion during the forthcoming session, when copies of the paper were available for circulation.

The following communication was then read :—

Mr. G. F. Marrian, M.Sc., and Dr. A. S. Parkes, M.A., Ph.D., F.R.M.S.—

“The Effects of Inanition and Vitamin B Deficiency upon the Testes of the Pigeon.”

DISCUSSION.

Mr. E. J. Sheppard asked at what season of the year the experiments were carried out, and whether the results observed could not be partially accounted for by seasonal variation.

Dr. Parkes replied that they were all done in the winter, but at the same time they were all done simultaneously, and, further, the results obtained were all checked with control birds, so that the question of seasonal variation would not enter into the results.

Dr. Rogers Brambell said that the testis and ovary alike were well known to be extraordinarily affected by any adverse circumstance, such as heat, inanition, and so on. Could Dr. Parkes give any reasons whether the changes taking place in the testis were simply an indication of the changes taking place in the whole body, but in a less marked extent, or whether they were changes more peculiar to the testis itself and their influence not exerted on the rest of the body, and could he say whether any of these birds were again given a full diet after they had been deprived of vitamin B for a considerable time, and, if so, whether they returned to a normal condition?

Dr. Parkes replied that the problem of regeneration was not gone into. In order to do that thoroughly it would be necessary to remove one testis at the end of the deficiency period. His experience was that regeneration did not take place to any extent.

The following paper by Miss M. E. Shaw, M.Sc., and Dr. F. W. Rogers Brambell, B.A., D.Sc., Ph.D., F.R.M.S., “An Aberrant Ovary in a Frog,” was then communicated by Miss M. E. Shaw.

The following papers were read in title :—

Mr. S. C. Akehurst, F.R.M.S.

“A Method of Illuminating Greenough Binocular Microscope by Transmitted Light with Paired Mirrors.”

Mr. J. E. Barnard, F.R.S., P.R.M.S., and Mr. F. V. Welch, F.R.M.S.

“An Electrically Heated Warm Stage with Compressor for use with High Powers.”

Dr. W. R. Ivey Cook and Miss I. R. Price.

“The Effect of Aeration and Light on the Development of the Zoosporangia in the Genus *Cladophora*.”

Votes of thanks were accorded to the authors of the foregoing communications, and to Messrs. E. Leitz for the loan of microscopes.

The President announced that the International Congress of Photography would be held from July 9th to 14th, and invited the co-operation of Fellows.

The President also announced that the Society's publication on the Origin and Development of the Microscope, including the Illustrated Catalogue of the Society's Historical Collection of Instruments and Accessories, edited by Mr. Alfred N. Disney, in collaboration with Mr. Cyril F. Hill and Mr. W. E. Watson Baker, was now ready, at the published price of 17s. 6d.—price to Fellows, 15s.—postage 9d.

The President expressed the thanks of the Society to Mr. Disney and his collaborators for their valuable services and for the meticulous care with which this publication had been prepared.

Carried with acclamation.

The President further announced that the Annual Pond Life and General Microscopical Exhibition would be held on Wednesday, June 6th, in the Lecture Hall and Library from 7.30 to 10 p.m., and invited Fellows to assist by bringing living or other microscopical specimens for exhibition at this Meeting.

The business proceedings then terminated.

JOURNAL
OF THE
ROYAL MICROSCOPICAL SOCIETY.

SEPTEMBER, 1928.

TRANSACTIONS OF THE SOCIETY.

IX.—THE EFFECTS OF INANITION AND VITAMIN B*
DEFICIENCY ON THE TESTIS OF THE PIGEON.

By G. F. MARRIAN (Beit Memorial Research Fellow) and
A. S. PARKES (Beit Memorial Research Fellow).

*(From the Department of Physiology and Biochemistry, University College,
London, and Laboratoire de Chimie biologique, l'Institut Pasteur, Paris.)*

(Read May 16, 1928.)

FIVE PLATES AND ONE TEXT-FIGURE.

I.—INTRODUCTION.

THAT the testes of laboratory animals fed on diets deficient in Vitamin B usually show atrophy and severe degenerative changes has been observed by numerous investigators—Funk and Douglas (1914), Drummond (1918), McCarrison (1919), Novarro (1920), Parkes and Drummond (1925).

It has frequently been pointed out in previous communications from this laboratory that the symptoms of vitamin B deficiency are often obscured by, and may be confused with, those due to the accompanying state of inanition that results from the disinclination of the animal to eat the deficient diet (Drummond and Marrian (1926), Kon and Drummond (1927), Marrian, Baker, Drummond and Woollard (1927)). Pigeons fed on a diet deficient in vitamin B usually do not show the typical polyneuritic symptoms until they have lost as great a percentage of their body weight as birds dying from inanition.

* Throughout this work Vitamin B refers to the accessory food factors necessary for animal nutrition present in yeast extract, Vitamin B₁ to the antineuritic substance in yeast required to cure symptoms of neck retraction in the pigeon, and Vitamin B₂ to the thermostable factor that is necessary for maintenance of good health and growth in the rat in addition to the antineuritic vitamin.

McCarrison (1919) showed that pigeons dying from starvation at a time when they had lost 23 p.c. of their original body weight, as well as birds feeding voluntarily on polished rice, had greatly atrophied testes. However, since the latter had lost about 30 p.c. of their body weight when the polyneuritic symptoms appeared, it might be reasonable to suppose that the atrophy was mainly due to the accompanying inanition. On the other hand, the possibility that the starvation atrophy is due partly to an accompanying state of vitamin B deficiency must not be excluded.

The present work was undertaken in order to clear up this point. In order to eliminate the "starvation factor," the birds were forcibly fed daily with larger quantities of the deficient diet than they would voluntarily consume. As previously shown by Marrian, Baker, Drummond and Woollard (1927), pigeons fed in this manner develop the typical symptoms more rapidly, and at a time when the loss of body weight is negligible. The effects of inanition, uncomplicated by possible effects of vitamin B deficiency, were studied on a group of pigeons that were entirely deprived of food with the exception that they daily received about 1 g. of yeast extract.

After preliminary work had shown that vitamin B deficiency alone could produce testis atrophy and degeneration, it was decided to investigate separately the effects of a deficiency of the two factors in the Vitamin B complex.

This point has already been dealt with by Findlay (1928), who has shown that rats fed on a diet deficient in only vitamin B₂ until the terminal pellagra-like symptoms occur may still display spermatogenesis. On the other hand, all those fed on diets deficient in vitamin B₁ show a complete absence of spermatozoa, even though receiving the deficient diet for only half as long as the other group.

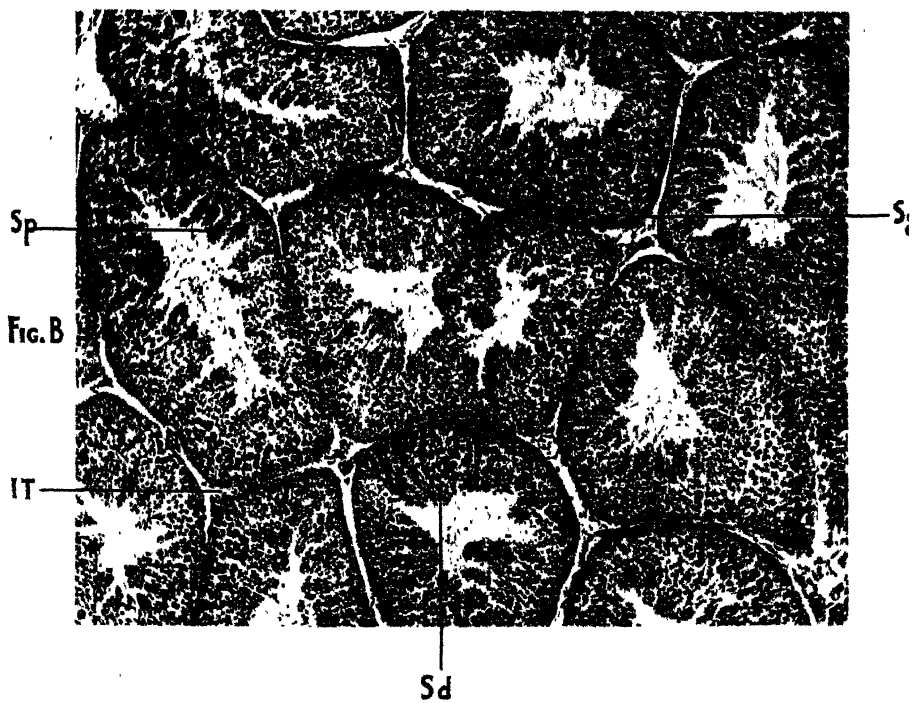
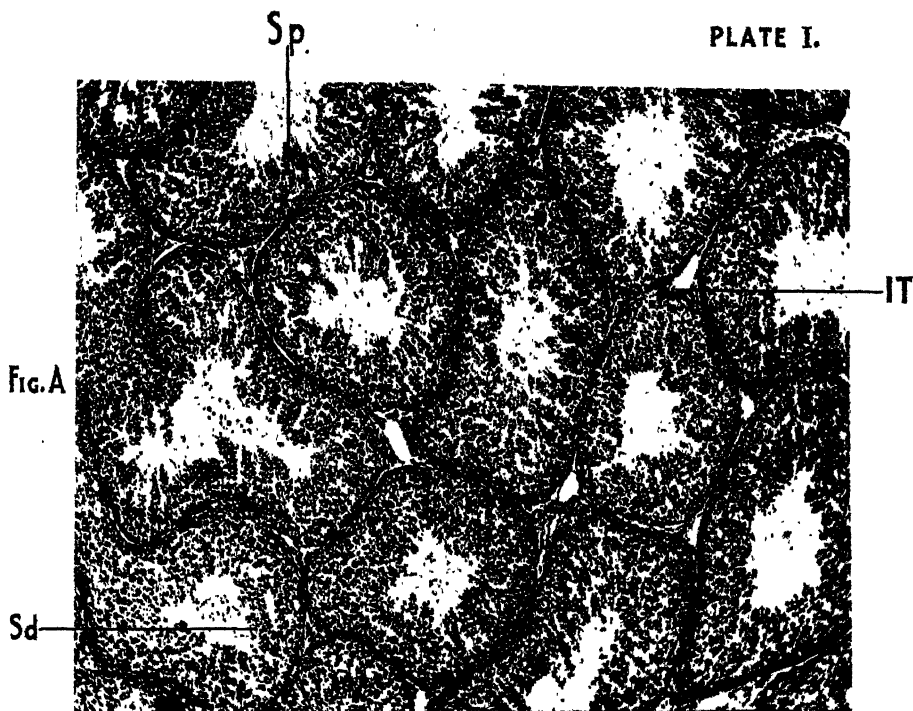
II.—METHODS AND MATERIALS.

All the birds were corn-fed for a week before going on to experimental diets. In a recent paper Kinnersley, Peters and Reader (1928) have laid stress upon the importance of standardisation of the diet before experiment.

The birds were then divided into five groups, which were arranged and treated in the following manner :—

Group.	Diet.	Vitamin preparations given.	Object of experiment.
A	20 g. Vitamin B deficient diet daily forcibly fed.	1 g. yeast extract daily..	Normal controls.
B	" "	—	Vitamin B deficiency.
C	" "	1 g. autoclaved yeast extract daily.	Vitamin B ₁ deficiency.
H	" "	Peter's Torulin curative dose X 3.	Vitamin B ₂ deficiency.
SM	Starving	1 g. yeast extract daily..	Inanition.

PLATE I.



The vitamin B deficient diet used in these experiments was one of the type devised by Randoin and Simmonet (1924), and was of the following composition :—

Rice starch	..	..	..	..	.	66 p.c.
Caseinogen	..	..	..	..	.	16 p.c.
Agar-agar	..	..	..	..	.	8 p.c.
Butter	..	..	..	..	.	4 p.c.
Paper pulp	..	..	..	..	.	2 p.c.
Salt mixture (McCollum)	..	..	..	..	.	4 p.c.

The methods of preparing the diet and of feeding it forcibly are fully described in previous papers (Kon and Drummond (1927), Marrian, Baker, Drummond and Woollard (1927)).

The yeast extracts used were 10 p.c. solutions of a commercial yeast preparation (marmite). The autoclaved extract was prepared by heating this solution, which had been made slightly alkaline with NaOH to 120° C. for three hours. Before use the solution was carefully neutralised with HCl.

The antineuritic preparation was prepared according to the method of Kinnersley and Peters (1927).

These preparations were administered to the pigeons once a day directly into the crop through a catheter tube.

The initial weight of each pigeon was recorded after a preliminary starving period of 24 hours, in order to minimise possible errors due to an overloaded crop. The birds in groups B and C were killed as soon as definite signs of polyneuritis were observed, while those in groups A and H (showing no terminal symptoms) were killed as soon after as was conveniently possible. The starving birds were killed at the beginning of the final collapse which has been previously described (Marrian, Baker, Drummond and Woollard (1927)).

Since pigeons showing the symptoms of polyneuritis, and in particular those that have been forcibly fed, are often severely crop bound, any food remaining in the crop was removed, dried and weighed, and this weight subtracted from the observed final body weight of the bird in order to arrive at the true final body weight.

Histological Technique.—The testes were removed from the birds immediately and fixed in Bouin's fluid, the tunica being first slit to allow of thorough penetration. Sections were cut at 7 μ and stained in Delafield's hæmatoxylin or Erlich's hæmatoxylin and eosin.

The sizes of the testis tubules were arrived at by measuring (from camera lucida outlines) the least diameter, this dimension being chosen to avoid the apparent exaggeration of diameter due to oblique sectioning. The original size of the testes was arrived at by ascertaining the total weight.

Statistical Methods.—The comparison of the size of testis and the size of tubule of the birds in the different groups involved certain problems of a statistical nature. The least diameters of ten tubules from each bird were measured and the values averaged. The mean diameter of the tubules in each group was calculated from the frequency distribution of the individual tubule diameters. The probable error was also calculated from the distri-

bution in the ordinary way $(0.6745 \frac{\sigma}{\sqrt{N}})$. The probable error of the difference in the means of two groups was considered as

$$0.6745 \sqrt{\left(\frac{\sigma_1}{\sqrt{N_1}}\right)^2 + \left(\frac{\sigma_2}{\sqrt{N_2}}\right)^2}.$$

III.—GENERAL BEHAVIOUR OF THE BIRDS.

Group A.—These birds behaved normally and appeared perfectly healthy. On one or two occasions individual birds vomited very small amounts of the diet immediately after feeding. However, this was never sufficient to be taken seriously into account, since the body weights were in all instances satisfactorily maintained. Unlike the birds in groups B and C, the food was rapidly passed out of the crop within a short time of each feeding.

Groups B and C.—Since no striking difference could be observed in the behaviour of the birds in these two groups, it will be convenient to deal with them together.

For about the first week these pigeons appeared quite normal; after this, however, a considerable amount of vomiting was observed in all cases. In spite of this, the body weights showed no serious loss, and thus it would appear that the greater portion of the diet was retained and metabolised.

The third phase, which appeared about a week later, was characterised by fairly severe crop binding. This condition lasted for about three days, when the typical nervous symptoms appeared. In the majority of cases the classical symptoms of neck retraction were observed, but there were also several instances of McCarrison's (1921) *emprosthotonus*, where the neck is bent forwards and downwards.

Group H.—Vomiting of about the same degree of severity and occurring at about the same time as that in the two preceding groups was observed in every case. This, however, did not appear to become noticeably more severe after the first ten days, and the general condition of the birds, when they were killed on the twenty-third day, was little worse than at the tenth day.

Group SM.—The general condition of the pigeon during inanition has been fully discussed previously (Marrian, Baker, Drummond and Woollard (1927)).

Details of the weight changes of the birds and the length of time during which they were fed on the deficient diets are shown in Table I.

IV.—WEIGHT OF TESTES AND SIZE OF SPERMATIC TUBULE.

Weight of Testes.—Table I shows the weights of the two testes of the individual birds and also the group averages. These figures show that even among birds of the same group considerable variation in the size of the testes was found. This variation does not appear to be correlated with (a) time on diet, or (b) weight of bird (not shown in the Table), or (c) change in weight while on diet, and since it can hardly be ascribed to seasonal changes, it would seem to be fortuitous. As shown below, the group averages for testis weights are closely correlated with the group average for size of

PLATE II.

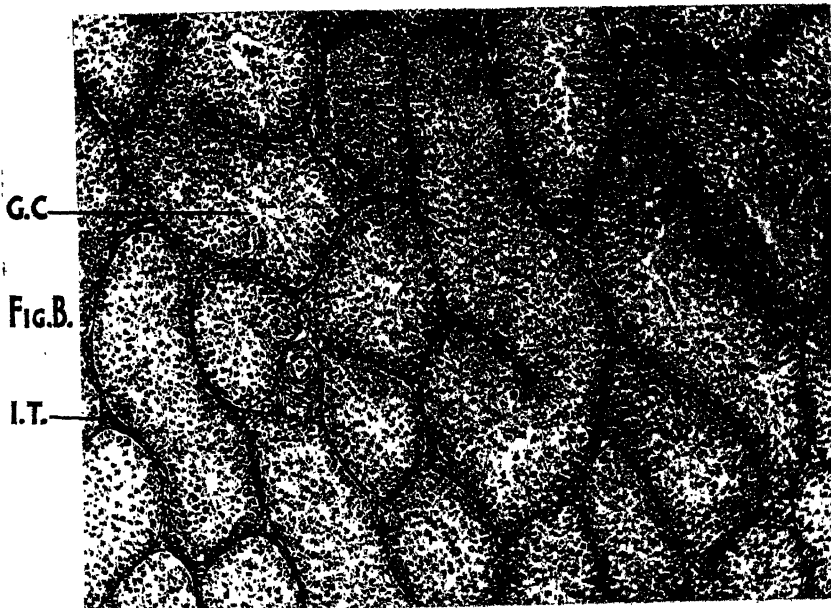
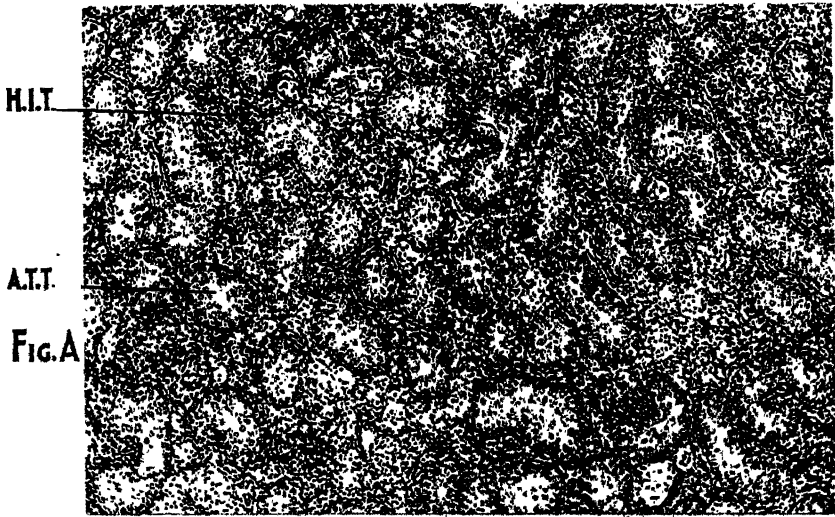


TABLE I.

No. of pigeon.	Days on diet.	Change in weight.	Weight of testes (g.).	Average diameter of tubule in m.m.
		per cent.		
A 39	22	+ 12.1	3.673	-0203
43	22	+ 11.3	2.436	-0215
40	24	+ 2.1	0.279	-0188
3	25	+ 22.4	0.802	-0154
44	25	+ 17.6	1.245	-0186
6	26	+ 19.1	0.617	-0154
37	26	- 5.1	1.433	-0211
Average ..	24	+ 12.8	1.498	-0189
B 8	18	+ 8.2	—	-0066
50	19	- 17.6	0.091	-0055
11	21	+ 1.1	0.101	-0067
10	22	- 18.6	0.056	-0057
52	16	- 2.8	0.354	-0097
45	17	- 3.2	0.329	-0107
51	19	- 11.6	0.437	-0097
48	24	- 17.4	0.381	-0097
Average ..	20	- 7.7	0.257	-0080
C 66	15	*	1.397	-0139
61	16	+ 1.6	1.284	-0169
57	18	+ 5.7	0.199	-0071
64	18	+ 10.5	1.199	-0134
65	20	- 2.5	0.525	-0129
18	22	- 2.0	0.160	-0067
59	22	+ 1.0	0.370	-0115
Average ..	19	+ 2.4	0.733	-0118
H 67	23	- 9.4	0.762	-0146
68	23	+ 2.9	0.397	-0097
69	23	- 7.2	0.723	-0141
70	23	- 12.8	0.781	-0134
72	23	- 15.0	1.233	-0139
Average ..	23	- 8.3	0.779	-0131
SM 75 ..	11	- 34.6	0.481	-0125
73 ..	17	- 37.7	0.329	-0118
74 ..	17	- 38.8	0.561	-0116
76 ..	21	- 37.2	0.301	-0107
78 ..	22	- 40.4	0.234	-0076
Average ..	18	- 37.7	0.381	-0109

* This bird was extremely cedematous, hence the change in weight is of no significance.

spermatic tubule. No correlation seems to exist, however, (a) between the individual weights of testes within the groups and the individual tubule size average (except in the B group), (b) the testis weight and the histological appearance.

In considering the weight of the testes, it is necessary to remember the possibility of an cedematous condition affecting the results. Some of the birds, notably C66, showed a general condition of extreme cedema, and it has previously been reported that the testes of rats kept on B deficiency

diets showed a considerable accumulation of fluid within the tunica (Allen (1919), Parkes and Drummond (1925)). In the pigeons, however, neither macroscopic nor microscopic signs of any marked cedematous condition of the testes have been observed.

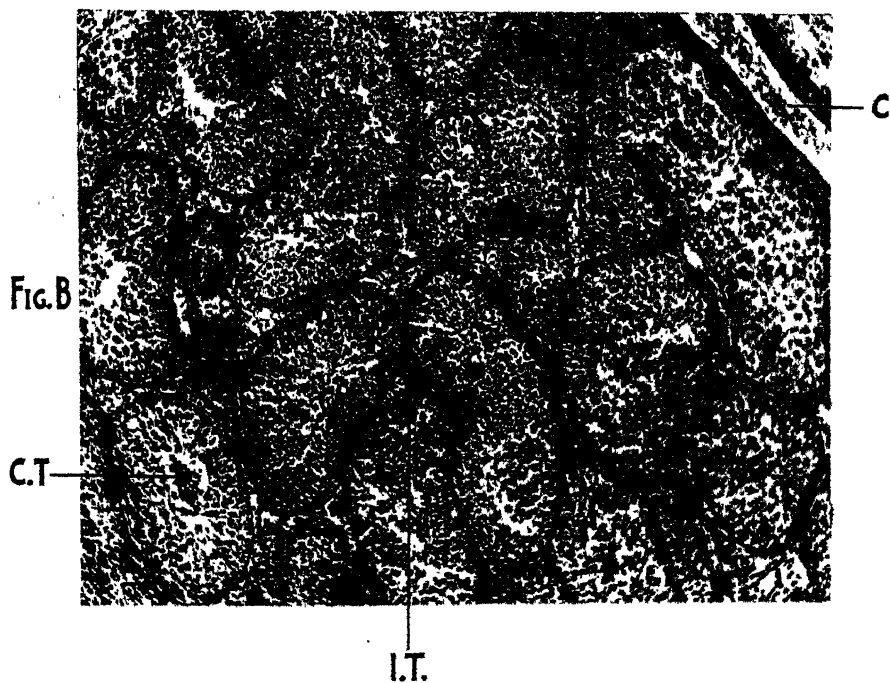
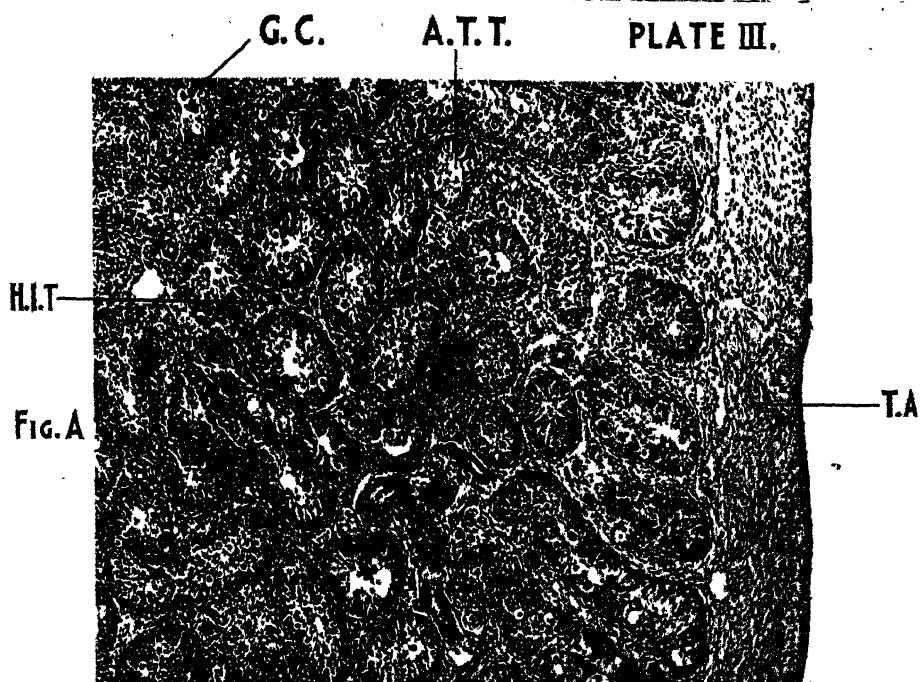
The group averages show roughly the results which might have been anticipated, i.e. that the birds on the complete synthetic diets had the largest testes, while those on total vitamin B deficiency had the smallest. The intermediate weight of the testes of the C and H birds is also not surprising, but the approximation of the SM testis weights to those of the B animals is closer than originally seemed probable.

The eight birds in B group are remarkable for falling definitely into two sub-groups. Birds B8, 10, 11, 50 comprise the first group, and B45, 48, 51 and 52 the second. This subdivision is apparent from (a) testis weight, (b) tubule size, (c) histological appearance. It is probable that these two conditions represent different stages of the same process, but it is convenient to consider them as separate groups so far as weight of testis and size of tubule are concerned.

Size of Spermatic Tubule.—The averages of the ten tubule measurements made on each bird are given for each individual in Table I. Within each group the individual averages vary considerably, and in order that the groups could be compared accurately the frequency distributions of all tubule measurements in the five groups were ascertained. These distributions are given in Table II.

TABLE II.
FREQUENCY DISTRIBUTIONS OF TUBULE SIZE ACCORDING TO DIET.

Size of tubule (μ).	Diet.					Total.
	A.	B.	C.	H.	SM.	
36-45 ..	—	1	—	—	—	1
46-55 ..	—	10	—	—	—	10
56-65 ..	—	15	6	—	1	22
66-75 ..	—	15	10	1	4	30
76-85 ..	—	6	3	1	6	16
86-95 ..	—	9	2	2	2	15
96-105 ..	—	11	3	4	3	21
106-115 ..	—	6	2	5	14	27
116-125 ..	2	6	12	2	9	31
126-135 ..	1	1	10	13	5	30
136-145 ..	1	—	4	6	2	13
146-155 ..	2	—	6	11	4	23
156-165 ..	7	—	6	3	—	16
166-175 ..	12	—	3	0	—	15
176-185 ..	9	—	1	2	—	12
186-195 ..	6	—	2	—	—	8
196-205 ..	10	—	—	—	—	10
206-215 ..	6	—	—	—	—	6
216-225 ..	5	—	—	—	—	5
226-235 ..	6	—	—	—	—	6
236-245 ..	0	—	—	—	—	0
246-255 ..	1	—	—	—	—	1
256-265 ..	2	—	—	—	—	2
Total ..	70	80	70	50	50	320



From these distributions the following means and probable errors can be calculated.

TABLE III.
MEAN SIZE OF SPERMATIC TUBULE.

Group.	Mean.	p.e.
A	189.1 μ	\pm 2.36
B	79.9 μ	\pm 1.71
C	117.6 μ	\pm 2.91
H	130.8 μ	\pm 2.23
SM	109.0 μ	\pm 2.19

These mean values compare as follows :—

TABLE IV.
COMPARISON OF TUBULE SIZE OF THE GROUPS.

Groups compared.	Difference (μ)	p.e. of difference.	Difference/p.e.
A and B	109.2	\pm 2.91	37.5
A and C	71.5	\pm 3.74	19.1
A and H	58.3	\pm 3.24	18.0
A and SM	80.1	\pm 3.22	24.9
B and C	37.7	\pm 3.37	11.1
B and H	50.9	\pm 2.81	18.1
B and SM	29.1	\pm 2.78	10.5
C and H	13.2	\pm 3.66	3.6
C and SM	8.6	\pm 3.64	2.4
H and SM	21.8	\pm 3.12	7.0

The only groups in which the difference is not statistically significant are C and H, C and SM, but groups B and C, B and SM, and H and SM show much less difference than the remaining ones. It may be said, therefore, that as regards tubule size, all the other groups (particularly B) differ markedly from A group, but that between the other groups the difference is much less, sinking to insignificance in groups C, H and SM.

Correlation between Weight of Testis and Size of Tubule.—The great variation in both weight of testis and size of tubule in individual animals almost precludes any precise correlation being found as regards the individual, but the group averages show a very striking correlation. The actual figures are given in Table V, while fig. 1. shows the results graphically.

TABLE V.

Group.	Weight of testis (g.).	Average size of tubule (mm.).
B (advanced birds)	.083	.0061
B (others) ..	.380	.0099
SM .. ..	.381	.0109
C .. ..	.733	.0118
H .. ..	.779	.0131
A	1.498	.0189

V.—HISTOLOGY.

In the rat (Allen (1919), Parkes and Drummond (1925)) it is possible to make out three fairly definite stages in the testis degeneration resulting from a deficiency of both vitamin B factors. These stages are:—

(a) Spermatocytes become degenerate and breakaway into the lumen of the tubule, where the beginning of a "core" is formed. Spermatozoa are still present at this stage.

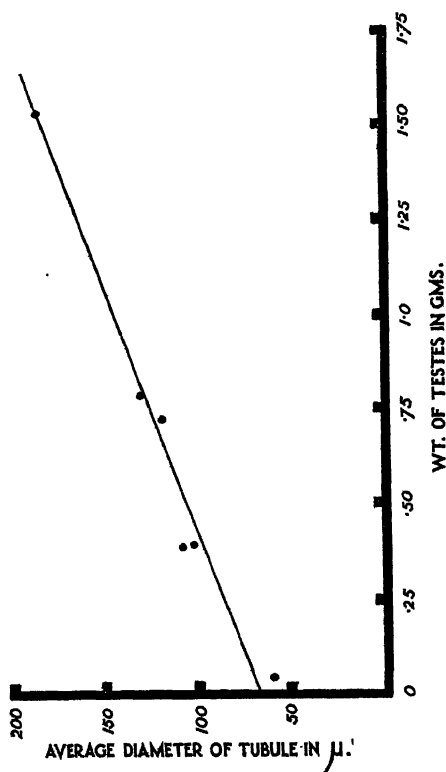


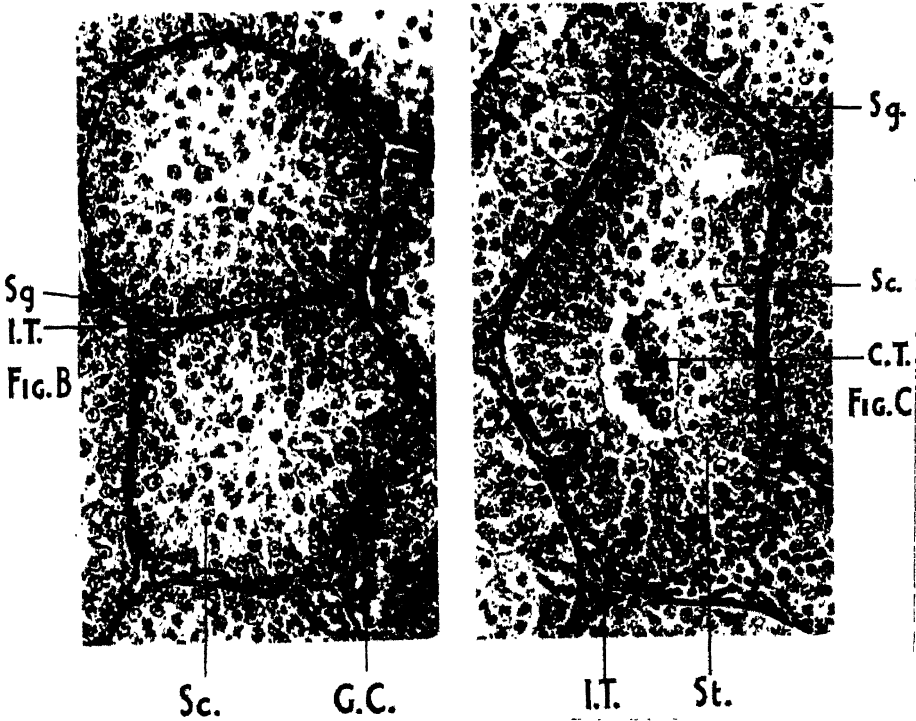
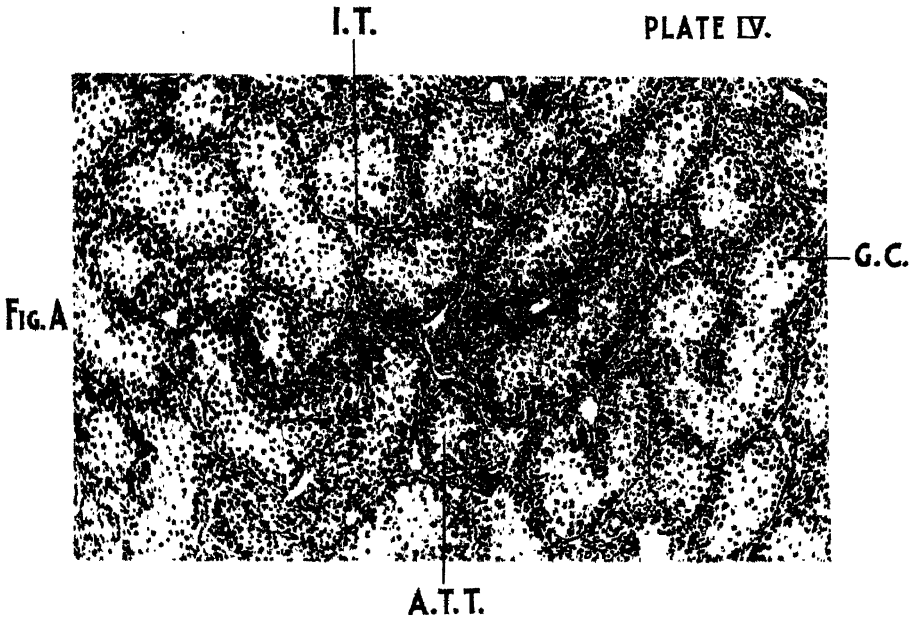
FIG. 1.

(b) The breakdown of further spermatogenic elements increasing the size of the core, and the lumen may be entirely occluded.

(c) The core may finally be evacuated, leaving the tubule almost empty. It was found that all three stages, together even with normal tubules, may be found in the same testis, and it is difficult to account for the extent of the variation.

In the testes of the pigeons recorded above a similar degree of variation from tubule to tubule and from bird to bird of the same group was observed.

PLATE IV.



The main features of the histological pictures presented by the testes are summarised in Table VI.

TABLE VI.
SUMMARY OF HISTOLOGICAL FINDINGS.

No. of bird.	Time on Diet. (Days.)	Sperma-tozoa.	Sperma-tids.	Sperma-tocytes.	Tubules with cores.	Empty tubules.	Giant cells.
A 39	22	+	+	+	+	0	0
43	22	+	+	+	+	0	0
40	24	+	+	+	0	0	0
3	25	+	+	+	0	0	0
44	25	+	+	+	0	0	0
6	26	+	+	+	0	0	0
37	26	+	+	+	0	0	0
B 8	18	0	0	+	+	+	+
				(but few)			
50	19	0	0	+	+	+	+
11	21	0	0	+	+	+	+
10	22	0	0	+	+	+	+
52	16	0	0	+	(solid)	0	+
45	17	0	0	+	(solid)	0	+
51	19	0	0	+	(solid)	0	+
48	24	0	0	+	(solid)	0	+
C 66	15	+	+	+	0	0	+
61	16	+	+	+	0	0	+
57	18	0	0	+	+	0	+
					(or solid)		
64	18	+	+	+	0	+	+
						(but few)	
65	20	0	0	+	0	+	+
18	22	0	0	+	+	0	+
59	22	0	0	+	+	0	+
					(or solid)		
H 70	23	+	+	+	0	0	+
68	23	0	+	+	(solid)	0	+
69	23	0	+	+	0	+	0
72	23	+	+	+	0	+	+
67	23	+	+	+	0	0	+
SM 75	11	0	+	+	0	0	+
73	17	0	0	+	+	0	+
74	17	0	0	+	+	0	+
76	21	0	0	+	+	0	+
				(but few)			
78	22	0	0	+	0	+	+
				(but few)			

NOTE.—The pluses merely indicate the presence of the various structures. No attempt is made to indicate the comparative number.

Group A.—The testes of the seven birds in this group were consistently normal (Plate I, fig. b). A3 and 6, however, had comparatively few spermatozoa, while A39 and 48 showed one or two tubules which had what appeared to be the beginning of degenerative cores. In order to investigate further the normality of this group, the testes of a normal corn-fed pigeon, known to be fertile, were examined (Plate I, fig. a). Except for showing a rather

more active spermatogenesis no difference could be detected between this bird and the A birds. One or two tubules from the corn-fed bird showed degenerative masses in the lumen, similar to Stage 1 of the vitamin B deficiency degeneration in the rat. It is evident, therefore, that the histological symptoms of vitamin B deficiency in the rat cannot be unreservedly applied to the pigeon.

Group B.—As is mentioned previously, the animals of this class fall into two distinct groups, the only feature in common being the absence of sperms.

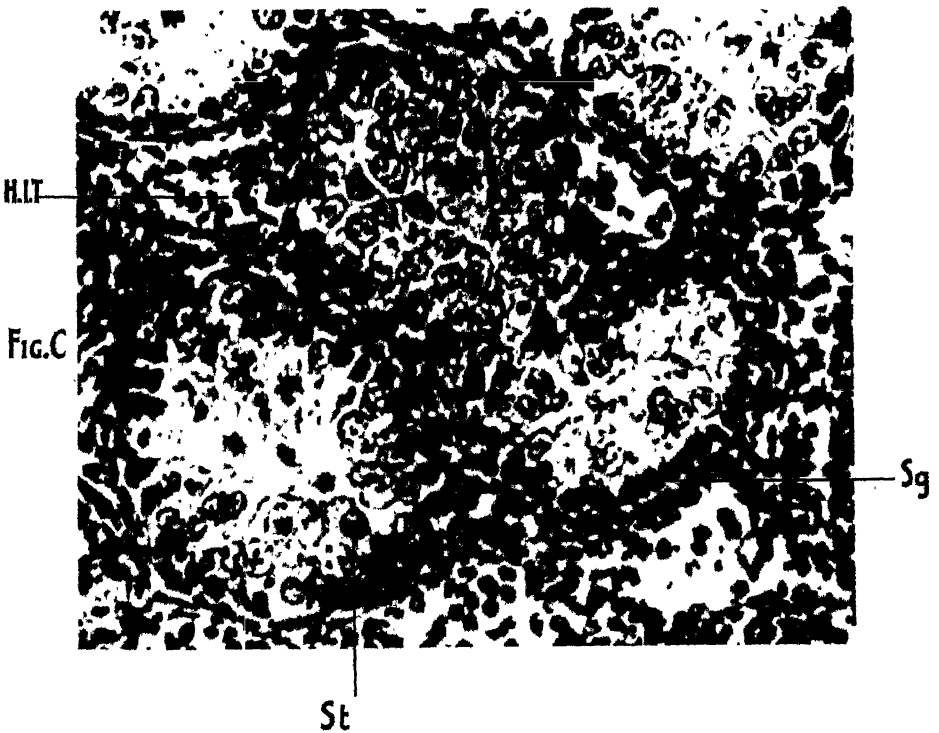
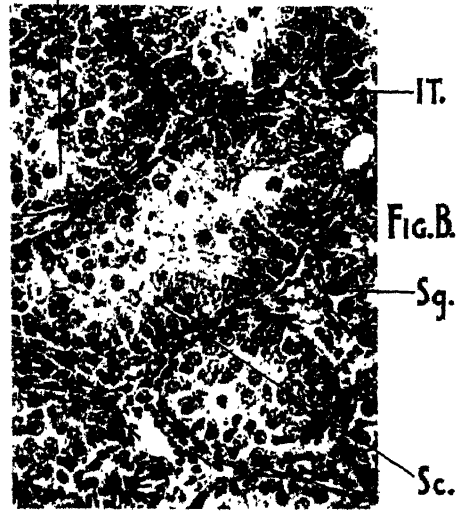
Four birds (B8, 11, 10, 50) had extremely small testes (Table I), which, histologically, presented a much shrunken appearance, with large intertubular spaces and small tubules (Plate II, fig. a). Some of the tubules possessed merely a few cells arranged round some semblance of a lumen, others possessed a solid core of pycnotic material in an otherwise empty tubule, while others, again, were almost denuded of cells.

In none of these birds were spermatids or spermatozoa observed, and the vast majority of tubules were devoid of spermatocytes also, and consisted merely of basement membrane, spermatogonia and Sertoli cells. Many of the more degenerate tubules (Plate V, fig. c) bore an extraordinary resemblance to embryonic testis tubules, and also to the structures found by Brambell, Parkes, and Fielding (1927) in X-irradiated mouse ovaries. These structures in the irradiated ovaries were originally thought to be rudimentary spermatid tubules, but later they were shown conclusively to be anovular Graafian follicles. The similarity of these tubules in the vitamin B deficient pigeon is thus most striking. The tunica albuginea of these birds was very thick, probably as the result of contraction. These four birds form a perfectly homogeneous group.

The other four birds of B group (B45, 48, 51, 52) show quite different characteristics. The testes themselves were much larger and presented few signs of shrinkage. The individual tubules were plump, and the intertubular space was in no area more than normal, while in certain areas the tubules appeared to be pushed together more closely than is usual. The tubules in this second class of complete vitamin B deficiency were characterised by being nearly all solid (Plate II, fig. b, and Plate IV, fig. b), though a few possessed cores in what appeared to be the original lumen (Plate IV, fig. c). It is doubtful, however, whether this core formation is a preliminary stage in solidification of the tubules. More probably it results from shrinkage in contents of the solid tubules. The solid tubules consist of a confused mass of spermatogonia, spermatocytes and Sertoli cells, together with pycnotic cells and giant cells. Neither spermatozoa nor spermatids have been observed in any of the B deficiency birds.

The precise significance of the occurrence of these two types of vitamin B deficiency effect is not quite clear, but it is probable that the condition found in B45, 48, 51, 52 is an earlier stage of the degeneration than that found in the others. Two considerations are against this idea, however, (a) no intermediate animals were found in the B group, and (b) the type of testis

G.C. PLATE V.



found was not correlated with the time on diet. These objections, however, are not very serious. In the first place, one small area in the testis of B48 shows tubules which are probably of an intermediate nature, and which can be contrasted with the rest of that testis which is typically of the other type. In addition, the testes of certain birds in other groups show intermediate stages. Secondly, the susceptibility of the individual birds to vitamin B deficiency varies very much, and since the general effect is not strictly proportional to the time on diet, it would be unreasonable to expect that the testis degeneration should be.

Group C.—The testes of the seven birds in this group show every graduation from the condition of the most affected in B group to sporadic occurrence of spermatogenesis. The three birds showing spermatozoa had been on diet respectively 15, 16 and 18 days. The testes, though containing spermatozoa and all stages of spermatogenesis were far from normal and were characterised by a general disorder of the tubules. The four other birds, showing no spermatozoa and except in one case no spermatids, had been on diet 18, 20, 22 and 22 days.

The less affected of the latter group, C59 and C65 (Plate III, fig. b), had testes similar to those in the less affected B group, and had numerous spermatocytes. In C65 considerable denudation of the tubule contents appeared to have taken place and some of the tubules were almost empty. The last two birds, C18 and C57 (Plate III, fig. a), had very degenerate testes, and are comparable with the B8, 11, 10, 52 group. No further description need therefore be given.

These results show that an adequate time on the vitamin B₁ deficiency will lead to all the histological testis symptoms of total vitamin B deficiency, and it might therefore be supposed that this fraction is the more important in maintaining the testis function. The results of B₂ deficiency, described below, tend to support this view.

Group H.—The five birds comprising this group were all on the diet for the same time, and, perhaps for this reason, show fairly regular histological effects. In three of the five (H20, 72, 67) complete spermatogenesis was present, though at the same time considerable derangement of the tubules occurred, and both spermatids and spermatozoa were scarce. In addition, some of the tubules were abnormal in showing a considerable amount of denudation. On the whole, however, these birds were by far the most normal of those on deficiency diets. The other two of this group (C68, 69) were less normal. In neither were spermatozoa present, and spermatids were few. C68 appeared to be identical with the birds of the second B group type (i.e., B45, 48, 51, 52), while C69 had many tubules which were partly denudated of their contents.

In none of these birds were any tubules found which showed the extreme degree of degeneration which is characteristic of the ultimate total B or B₁ deficiency, and the view that B₂ is of minor importance in testis nutrition is thus confirmed.

SM Group.—The testes of the inanition birds are interesting in that the degree of degeneration observed was strictly proportional to the time before death, as also was the size of tubule (Table I). In view of the fact that the body weight alteration by the time of complete exhaustion varied but little according to the time of inanition, the result as regards the testis tubules is somewhat surprising.

Histologically, the tubules of all the five animals in the group were found to be devoid of spermatozoa, though in SM75 all other stages, including spermatids, were present. In this bird, however, as in the other four, fissures running right to the basal membrane, split up the seminal epithelium into blocks. In the next stage, SM78, the spermatids had practically disappeared, but spermatocytes were still plentiful. Reabsorption or evacuation of the tubule content was beginning to take place. SM74, in inanition for the same length of time (17 days) showed no marked histological difference from SM78. Up to this stage the amount of intertubular space was comparatively normal, showing, as suggested by the figures for tubule diameter, that shrinkage was not yet extensive. In the remaining two birds, SM76 and 78, in inanition for 21 and 22 days respectively, a decrease in tubule size is found with a corresponding increase in intertubular space. In both these birds spermatocytes have become rare, and the tubule contents less. A few of the tubules in SM78 have become more or less empty, and present the appearance found in the rat on B deficient diets. Cores are present in some of the tubules in SM74 and 76.

SM78 (Plate IV, fig. 2) is the only one of the SM series which shows any indication of the degree of degeneration characteristic of the ultimate stage of complete B deficiency, and even this bird is distinct on account of:—

- (a) The greater size of the tubules.
- (b) Presence of spermatocytes.
- (c) Larger amount of cell contents. Some of the tubules in B8, for instance, contain less than a score of cells.

VI.—DISCUSSION AND SUMMARY.

The results described above make it evident that the testicular degeneration which results from vitamin B deficiency is not necessarily a starvation effect. This is shown by the fact that (a) one of the worst cases of testis degeneration actually gained in body weight during the dieting, and (b) the birds dying from inanition failed to present degeneration anything approaching as severe as the vitamin B deficient group.

The results also suggest most strongly that Vitamin B₂ is comparatively unnecessary as compared with the antineuritic fraction for the maintenance of testis nutrition.

The effects described above are one more example of the similarity of the degenerative changes which may be initiated in the testis by a wide

range of adverse conditions. The picture presented above is extraordinarily reminiscent of the testis following exposure to X-rays, and also of the characteristic condition due to non-descent or vasectomy. In each case the changes are typified by the successive disintegration and reabsorption of the spermatogenic elements in order of maturity, by the shrinkage of the tubules and by the increase (relative or absolute) of the intertubular matter. Spermatozoa spermatids, spermatocytes, and in cases even the spermatogonia disintegrate and disappear one after the other and in certain instances of X-ray destruction the Sertoli cells appear to be the sole surviving contents of the tubules.

The authors are again indebted to Professor Bertrand for providing accommodation in his laboratory during part of this work, while to Professor J. C. Drummond their thanks are due for help and advice.

REFERENCES.

- ALLEN (1919).—*Anat. Rec.* **4**, 16.
 BRAMBELL, PARKES, and FIELDING (1927).—*Proc. Roy. Soc., Series B*, **101**, 29.
 DRUMMOND (1918).—*Biochem. J.*, **12**, 25.
 DRUMMOND and MARRIAN (1926).—*Biochem. J.*, **20**, 1229.
 FINDLAY (1928).—*J. Path and Bact.*, **31**, 352.
 FUNK and DOUGLAS (1914).—*J. Physiol.*, **47**, 175.
 KINNERSLEY and PETERS (1927).—*Biochem. J.*, **21**, 777.
 KINNERSLEY, PETERS and READER (1928).—*Biochem. J.*, **22**, 276.
 KON and DRUMMOND (1927).—*Biochem. J.*, **21**, 632.
 MARRIAN, BAKER, DRUMMOND and WOOLLARD (1927).—*Biochem J.*, **21**, 1336.
 MCCARRISON (1919).—*Ind. J. Med. Res.*, **6**, 275.
 NOVARRO (1920).—"Gez. degli Ospedali," Milano, **41**.
 PARKES and DRUMMOND (1925).—*Proc. Roy. Soc., Series B.*, **98**, 117.
 RANDOIN and SIMMONET (1924).—*Bull. Soc. Chim. Biol.*, **6**, 601.

DESCRIPTION OF PLATES.

GUIDE LETTERS.

- Sg.—Spermatogonium.
 Sc.—Spermatocyte.
 Sd.—Spermatid.
 St.—Sertoli cell.
 Sp.—Clump of spermatozoa.
 A.T.T.—Atrophied testis tubule.
 C.T.—Core of disintegrating cells in lumen of tubule.
 I.T.—Interstitial tissue.
 H.I.T.—Hypertrophied (relatively) interstitial tissue.
 G.C.—Giant cell.
 T.A.—Tunica albuginea.
 C.—Capillary.

PLATE I.

- FIG. (a).—Testis of normal corn fed pigeon. $\times 130$.
 FIG. (b).—Testis of pigeon (A39) on complete synthetic diet. $\times 130$. This testis is indistinguishable from that of the bird kept on natural food.

PLATE II.

FIG. (a).—Ultimate stage of degeneration found in total vitamin B deficiency (Pigeon B50), showing the smallness of the tubules compared with normal (Plate I), the absence of spermatogenesis, and the relative if not absolute hypertrophy of the interstitial tissue. $\times 130$.

FIG. (b).—Intermediate stage of degeneration brought about by total B deficiency (Pigeon B51). Note absence of spermatozoa, solidity of tubules, and comparative lack of inter-tubular space. $\times 130$.

PLATE III.

FIG. (a).—Ultimate stage of degeneration on vitamin B₁ deficiency (Pigeon C18), showing similarity to condition found in total B deficiency. (Compare Plate II, fig. a). The thickness of the tunica albuginea shows the amount of shrinkage which has taken place. $\times 130$.

FIG. (b).—Intermediate stage of degeneration on vitamin B₁ deficiency (Pigeon C59), showing similarity to the intermediate stage on total B deficiency (Compare Plate II, fig. b). $\times 130$.

PLATE IV.

FIG. (a).—Testis SM78, showing greatest degree of degeneration produced by inanition. Comparison with Plate II shows clearly the greater effect of Vitamin B deficiency. $\times 130$.

FIG. (b).—Higher magnification of Plate II, fig. b (Pigeon B51), showing details of tubule contents, i.e. spermatogonia, spermatocytes and Sertoli cells. This solid tubule is typical of the early stages of B deficiency degeneration. $\times 300$.

FIG. (c).—Similar tubule of Pigeon B45, showing the central core of degenerate cells which is found in some few of the B deficiency tubules. $\times 300$.

PLATE V.

FIG. (a).—Higher magnification of testis of Pigeon C18 (Plate III, fig. a), showing extensive degeneration. $\times 300$.

FIG. (b).—Higher magnification of testis of Pigeon SM78 (Plate IV, fig. a), showing the presence of spermatocytes, and generally demonstrating the lesser degree of shrinkage and degeneration than is found in the later stages of either the total B or B₁ deficiencies. Note the comparative absence of the exaggerated intertubular space found in the latter. $\times 300$.

FIG. (c).—High magnification of the worst tubules in advanced B deficiency degeneration. (B50, compare Plate II, fig. a). Note similarity to anovular follicles and embryonic testis tubules. $\times 650$.

X.—AN ABERRANT OVARY IN A FROG.

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(From the Department of Zoology, King's College, London.)

(Read May 16, 1928.)

ONE PLATE.

THE abnormality described in this paper is, so far as we are aware, unique, and appears to be of sufficient interest to call for a short description. The frog (*R. temporaria*) in question attracted attention first during a practical class on January 28, 1928. We have inquired carefully into the source from which the batch of frogs used that day came, and are satisfied that all were wild specimens caught in Hertfordshire. They were sent directly to the laboratory on the day previous to that on which they were used. The abnormality must be considered, therefore, to have occurred in a state of nature, and not to be the result of any experimental treatment.

The abnormality was obvious externally as a large swelling, covered by apparently normal skin, on the ventro-median surface of the thigh, about midway between the hip and knee joints. On removal of the skin, which was loosely attached, the tumour beneath was completely exposed (Plate I, fig. 1). It was seen to consist of two easily distinguishable parts. The first was an approximately hemispherical mass of ovarian tissue (O), measuring about 8 mm. by 6 mm. in diameter, anteriorly situated and firmly attached to the muscles beneath. The second was an elongated mass of dark red-brown tissue, resembling kidney (K), in close contact with the posterior margin of the ovarian portion. This "kidney" measured approximately 10 mm. by 3.2 mm. The whole tumour was firmly attached to the adductor magnus, sartorius and rectus internus minor muscles of the leg. Subsequent dissection showed that the attachment was effected by a sheet of fibrous connective tissue binding the tumour to the muscle-fascia. The attachment was entirely superficial, the tissues of the tumour not penetrating the muscles at all, but lying on top of them. The whole tumour was well vascularised by arterioles entering at several points around the margin and apparently arising from the femoral artery.

The anatomy of the surrounding parts provided no clue as to how this

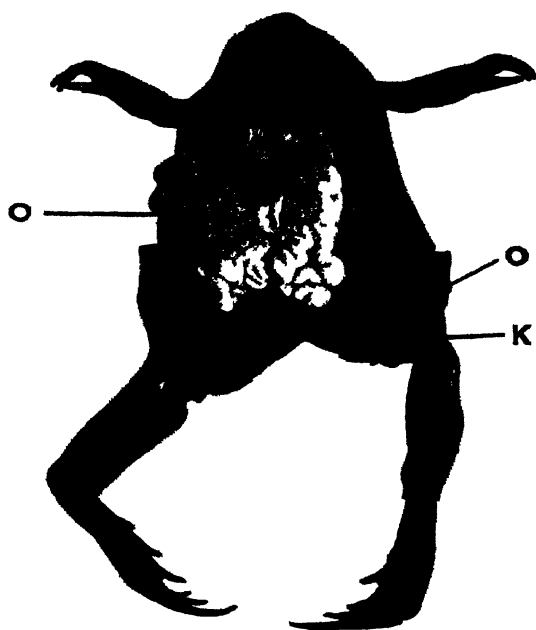
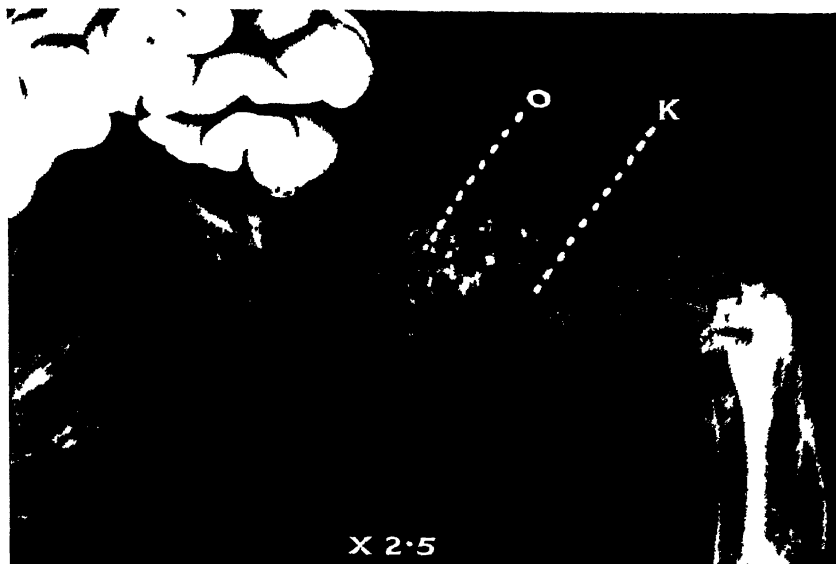
tumour originated in so unusual a site. No sign of any past or present rupture of the abdominal wall or hernial extension into the inguinal region was observable. In consequence it was thought that the tissue might have gained access to the subcutaneous lymph space, possibly during laying, through a cut in the overlying skin. Serial sections of the skin of this area failed, however, to reveal any trace of scar tissue. The frog was an apparently normal female in every way, save for the tumour in question.

The ovarian portion of the tumour appeared perfectly normal. No efferent ducts were associated with it. It contained many large pigmented oocytes approaching maturity and a number of smaller unpigmented ones. Histological examination showed these oocytes to be normal and not exhibiting any signs of degeneration or reabsorption.

The glandular portion of the tumour appeared, on histological investigation, to be degenerate kidney tissue. Degenerate urinary tubules lined by a typical epithelium were embedded in the stroma. These tubules had either a very small lumen or no lumen at all. A few spherical structures resembling degenerate Malpighian corpuscles were present. The urinary tubules were confined, as is usual, to one side of the kidney—in this case that attached to the ovary and the underlying muscles. The kidney was very well vascularised, being supplied with more numerous blood-sinuses than normal kidney tissue, and by two large arteries running longitudinally through the gland. These arteries were symmetrically placed, being situated one on each side of the kidney, equidistant from the dorsal and ventral surfaces. No trace of a ureter was found in connection with this renal tissue, the degenerate condition of which was probably a result of the absence of an outlet.

Aberrant tissues of various sorts have been described in many animals, but, so far as we know, no animal has been described with an ovary and a kidney half-way down its leg. How these tissues attained a site so far removed from their natural one, without leaving any trace of the path taken, is difficult to guess. The manner in which, once there, they became engrafted on the underlying tissues and efficiently vascularised is also remarkable. The fact that the skin showed no signs of a scar appears to preclude the possibility of the entrance of the tissue from outside. The passage of ovarian and renal tissue, from their normal site, through the abdominal wall and down the inguinal lymph spaces is almost equally difficult to understand. Another frog in the same batch possibly affords a clue to how this could take place. This specimen had a large hernial sac extending over the whole ventral surface of the abdomen and a short distance down the inguinal region of one leg. This sac opened into the abdominal cavity by a large orifice in the umbilical region through which the ovaries and oviducts, distended owing to the imminence of the breeding season, projected. The inguinal extension of this sac was occupied by a blood-clot in which was embedded a solitary degenerating egg.

If we suppose a similar condition to have existed at one time in the other



frog, it is possible to imagine that a portion of the ovary could become separated and engrafted on the adjoining tissues. At the close of the breeding season, when the ovaries and oviducts had hypotrophied to the winter condition and thus relieved the internal abdominal pressure, the rupture might close up and leave the extra-abdominal graft entirely isolated. After some time the traces of the old hernia might disappear, perhaps as completely as in our subject.

We are indebted to Mr. D. A. Kempson for the photographs reproduced in the accompanying plate.

XI—THE EFFECT OF AERATION AND LIGHT ON THE DEVELOPMENT OF THE ZOOSPORANGIA IN THE GENUS *CLADOPHORA*.

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(Read May 16, 1928.)

FOUR PLATES AND ONE TEXT-FIGURE.

It has been known for some time that the intensity and wave-length of light has a direct influence upon the growth of an organism, and that, moreover, among the algæ some genera have the power of turning the light of one wave-length to their own advantage, while to other genera this light is of not the same value. Klug (1925) has shown in both *Volvox aureus* and *Closterium acerosum* that photosynthesis is a wave-length phenomenon and not a matter of the total intensity of the light. He came to the conclusion that if reproduction is taken as a criterion of photosynthetic activity, then photosynthesis is a wave-length phenomenon, red light being most efficient, blue much less so, and green inefficient.

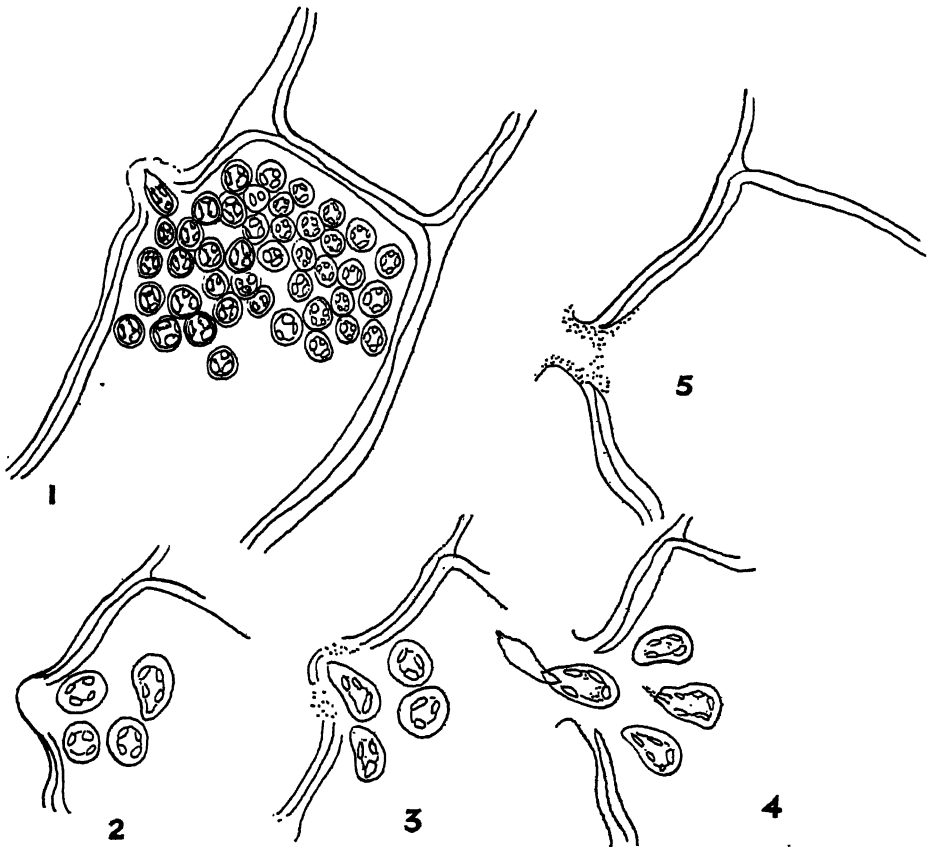
The experiments which form the subject of the first part of this paper were conducted with a twofold object, in the first place to discover a satisfactory way of obtaining asexual reproduction in the Cladophoraceæ, and in the second to investigate the effect of various physiological conditions upon the frequency and character of the process. Very little is known about the asexual reproduction of any member of this family, and a study was made of the method of zoospore discharge and the subsequent behaviour of the zoospores up to their development into a fresh filament. Two species of *Cladophora* were selected, which were as unlike in their general structure as possible. *Cladophora crispata** was obtained from a pond in the Chelsea Physic Gardens, London, through the kindness of the Curator, Mr. W. Hales; *Cladophora glomerata*† was collected from the River Darent near Farningham, Kent. It was found possible to maintain supplies of both species in the department during the course of the experiments.

THE EFFECT OF AERATION AND LIGHT ON SPECIES OF *Cladophora*.

Experiments were first conducted with *Cladophora crispata*. It was found that when this species was growing in stagnant water no zoosporangia were developed even in a strong light, so that a stock of the alga, although

* *Cladophora crispata* (Roth) Kutz. ampl. Brand.

† *Cladophora glomerata* (L.) Kutz. ampl. Brand.



remaining healthy and increasing by vegetative means, did not produce any reproductive organs, either sexual or asexual.

Small quantities of the material were placed in beakers in tap water and subjected to constant aeration. The apparatus used for this purpose has been working at King's College for many years, and has been recently redescribed in a slightly modified form by Cannon and Grove (1927). The alga in this way was supplied with air, although the water was not changed. The results obtained by this means were then compared with specimens set up in darkness and in coloured light.

The method used in these experiments was as follows:—

A long box was made, consisting of a number of light-tight compartments. In the front of each an opening was cut, 8 in. by 6 in. in size, and over it a piece of clear glass or a Wratten filter was fixed. The back of the box was fitted with a hinged door to allow the alga to be inspected during the course of the experiments. In the top of each compartment was a small hole through which a glass tube passed carrying the air from the aeration apparatus. The front of the box was placed against a window and illuminated with daylight. The front of one compartment was blocked with black card and served as a light-tight box for comparison with those admitting light. The light filters used were Wratten filters Nos. 25, 49, and 58, which are described as the Tricolour series. Their dominant wave-lengths are 625, 470 and 535 $\mu\mu$ respectively. In each compartment was hung a thermometer. It was found, however, that there was little or no difference in the heat in the various chambers. As the work was done during rather cold weather, the whole box was stood on a warm plate, which was used if the temperature fell below about 10° C.

Using this method the following observations were made:—

TABLE I.
Cladophora crispata PLACED IN BOXES FEBRUARY 20.

Date.	Light.	Darkness.	Red Light.	Blue Light.	Green Light.
Feb. 25	Few zoospores	—	—	—	—
„ 26	Many zoospores	Few zoospores	—	—	—
„ 27	—	Few zoospores	Few zoospores	—	—
„ 28	—	—	Many zoospores	Zoospores	—
„ 29	—	—	—	Many zoospores	—
March 1	—	—	—	—	—
„ 2	—	—	—	—	—

The temperature was maintained throughout the experiments at 25° C.

It will be seen from this table that zoospores are most readily produced in ordinary daylight, and that they subsequently develop in darkness, red and then blue light, but that they are not produced at all in green. After

a filament had discharged its zoospores it apparently dies, except in cases where not more than 50 % of the cells of the filament formed zoosporangia. It became apparent that this species of *Cladophora*, when living in water without aeration, remains in a more or less vegetative state, but that when supplied with aeration developed zoospores in daylight after five days. These experiments were repeated with practically identical results. Klebs (1896) found that conditions for vegetative growth are usually antagonistic to reproduction.

In order to test whether the same results would be obtained if the alga was supplied with light during the whole twenty-four hours, the apparatus shown in text-fig. 1 was set up.

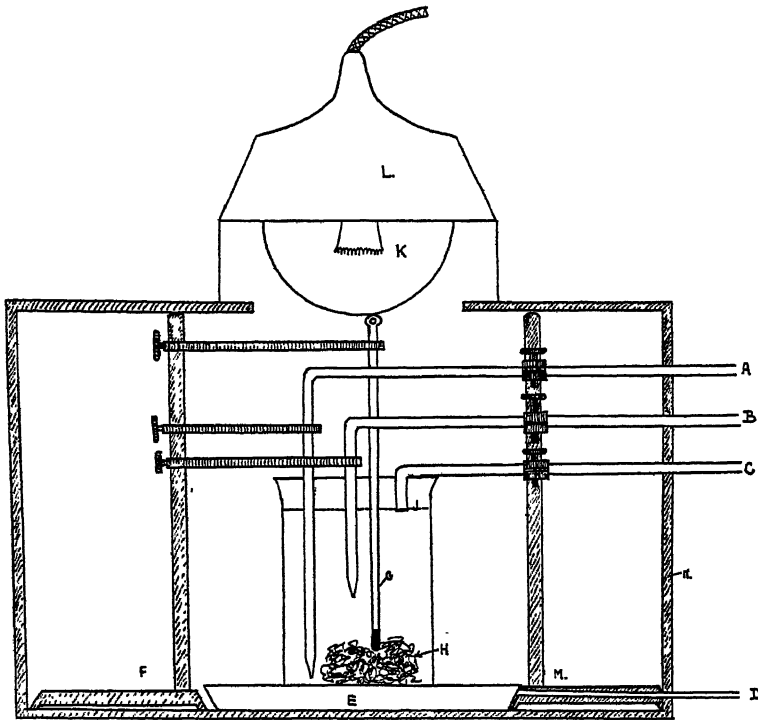
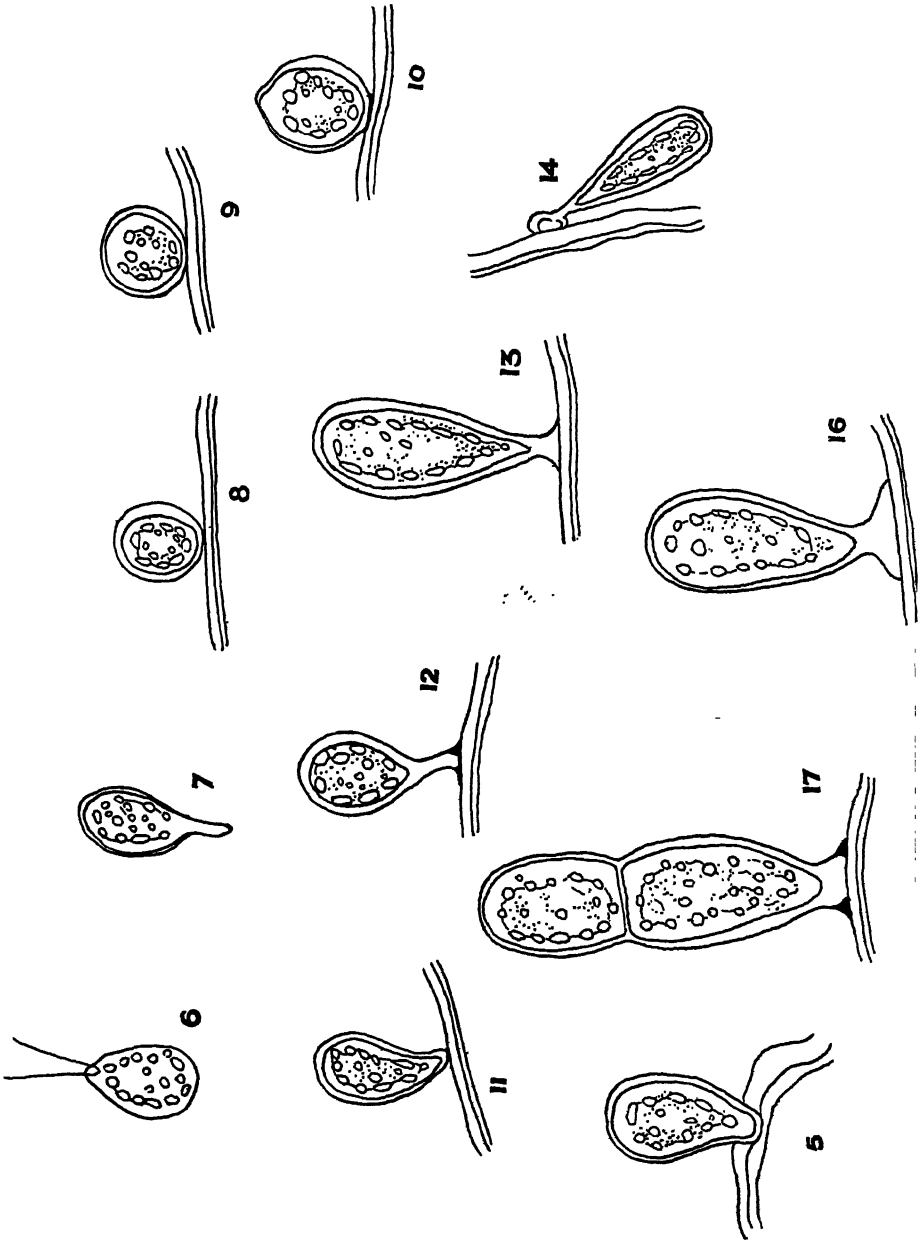


FIG. 1.—Apparatus for growing *Cladophora* under constant electric light. A, Water inlet; B, air inlet; C, water outlet; D, over-flow outlet; E, tray for carrying off extra water; F, retort stand; G, thermometer; H, alga; J, water level; K, electric lamp; L, shade; M, retort stand; N, wooden light-tight box.

In this experiment it was found necessary to change the water continually, in order to maintain a constant temperature owing to the heat given out by the electric light. In the first instance a lamp of 500 watts was used, but subsequently one of 750 watts was employed. The temperature was maintained at between 10° and 11° C. The alga was placed in the beaker on February 25, and examined daily. It was noticed that the amount of



branching was reduced, and that after three days had practically stopped. After five days one filament was found which had developed zoosporangia, the zoospores, however, appeared sluggish and were obviously not healthy. For the next three days a few zoospores continued to be discharged from this filament, but they did not appear capable of germination. The cells of the whole mass of alga, moreover, were showing signs of disorganisation and the experiment was discontinued.

It will be seen, therefore, that when the alga is illuminated with electric light during the whole twenty-four hours, it has a deleterious effect upon it. In order to compare the effect of electric light and daylight together the same apparatus was used, but the light was switched on at 9 a.m. and off at 6 p.m. Some of the *Cladophora crispata* was put in on March 8 and plenty of zoospores were found six days later. Comparing this result with that obtained when the alga was supplied with aeration and daylight, it will be seen that the time taken in this experiment is intermediate between daylight and total darkness, which is what one would expect.

Experiments were also carried out using a Knop's culture solution of different strengths. For this purpose the following stock solution was made up:—

Potassium nitrate (KNO_3)	..	..	..	1 grm.
Magnesium sulphate (MgSO_4)	..	..	..	1 grm.
Calcium nitrate ($\text{Ca}(\text{NO}_3)_2$)	..	..	..	3 grms.
Potassium phosphate (K_2HPO_4)	..	..	..	1 grm.
Water	..	..	..	1000 c.c.

This was considered for practical purposes to be a 0.6% solution. The results are set out in Table II.

TABLE II.

STRENGTH OF KNOP SOLUTION USED.					
Date	0.6	0.4	0.3	0.2	0.1
March 22	—	—	—	—	—
" 23	—	—	—	—	—
" 24	—	—	—	—	—
" 25	—	—	—	—	—
" 26	—	Zoospores	—	—	—
" 27	—	Zoospores	—	—	Zoospores
" 28	—	—	Zoospores	Zoospores	Zoospores
" 29	—	—	Zoospores	Zoospores	—
" 30	—	—	—	—	—

It will be seen that zoospores first appear in 0.4% solution and next in 0.1%, the following day they were found in 0.3% and 0.2%, but not at all in 0.6%. The rate of zoospore formation is therefore roughly equal to that induced by aeration. In each case it was found that the zoospores continued to appear for two days. After that no more were found.

The illumination experiments were repeated with *Cladophora glomerata*. This species normally grows in fairly rapidly flowing water. A number of plants attached to stones were collected and brought into the laboratory. The quantity of alga growing on a single stone was used for each experiment. The experiment set out in Table I was repeated with the following results :—

TABLE III.

Cladophora glomerata PLACED IN BOXES MARCH 24.

Date.	Light.	Darkness.	Red Light.	Blue Light.	Green Light.
March 27	—	—	—	—	Zoospores
" 28	—	—	—	—	—
" 29	—	—	—	—	—
" 30	Zoospores	—	—	—	—
" 31	Zoospores	—	—	—	—
April 1	—	Zoospores	—	—	—
" 2	—	Zoospores	Zoospores	—	—
" 3	—	—	Zoospores	Zoospores	—
" 4	—	—	—	Zoospores	—
" 5	—	—	—	—	—

The temperature was maintained throughout the experiments at 12° C.

It will be seen that *Cladophora glomerata* agrees with *Cladophora crispata*, in that zoospores are developed first in the light then in darkness, and subsequently in red and blue light, but that they are not formed in green light at all. The discharge of zoospores which occurred on March 27 is thought to be due to zoosporangia which had developed before the experiment was set up, as the alga was placed in the beakers immediately after being removed from the river. When the experiment was repeated in green light subsequently no zoospores were found.

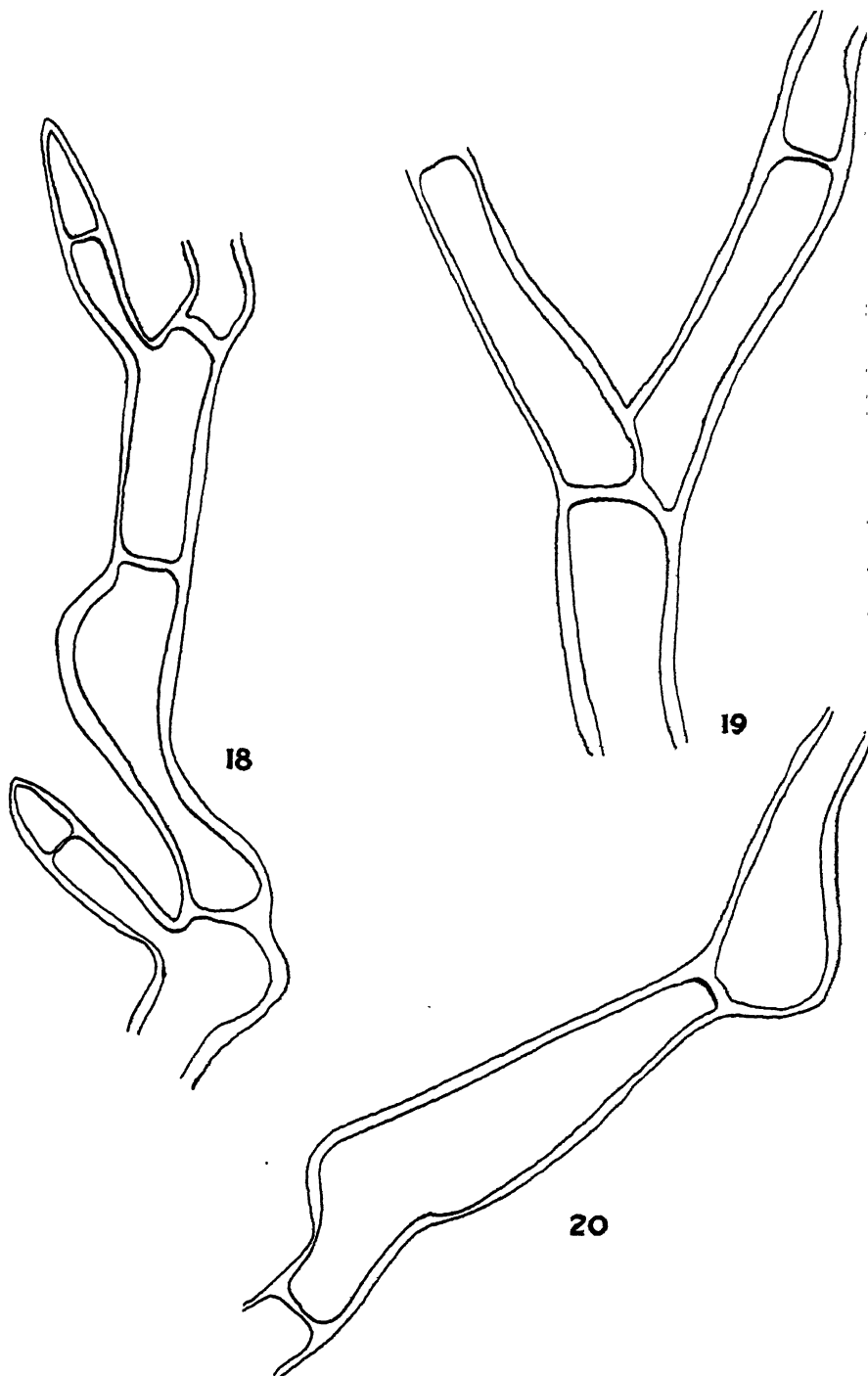
Cladophora glomerata differs from *Cladophora crispata* in the time taken to form zoospores under similar conditions. This will be seen from the following table :—

TABLE IV.

TIME IN DAYS.

Species.		Daylight.	Darkness.	Red Light.	Blue Light.	Green Light.
<i>C. crispata</i>	..	5-6	6-7	7-8	8-9	—
<i>C. glomerata</i>	..	6-7	8-9	9-10	10-11	—

The time taken by *Cladophora glomerata* to form zoospores in discontinuous electric light was also tried. The experiment was set up on March 24, and a general discharge took place from six to seven days later. This was the same time as was taken by this species to form zoospores in daylight, and also that taken by *Cladophora crispata* with discontinuous electric light.



It would seem, therefore, that the intensity of light does not effect the time of discharge, and that, moreover, the two species behave very similarly to identical physiological conditions.

THE DISCHARGE AND GROWTH OF THE ZOOSPORES OF
Cladophora crispata.

It was generally found that each cell of a filament became a zoosporangium, and after the liberation of the zoospores long filaments are seen which are quite colourless, each cell of which shows the exit by which the zoospores escaped. Prior to the formation of the zoospores within the zoosporangia the chloroplasts aggregate themselves together and form polyhedral masses, and a gradual cleavage appears in the cell delimiting the zoospores, as has been described by Strasburger (1880). The wall of the zoosporangium at this stage always shows a swelling (fig. 20) which is usually in the upper part of the cell. The rupture always takes place at this point, water is taken in, and the swollen part increases in size (fig. 1) until a small circular opening is formed (figs. 1-5). Meanwhile the zoospores have developed within the zoosporangium and their flagella have already become differentiated. The emergence of the zoospores is a sudden rapid process suggesting an explosion of the content of the cell. The zoospores nearest the opening migrate rapidly through the small orifice, becoming constricted as they make their way through the cell (figs. 1 and 3). More zoospores continue to stream through the opening and make their escape (figs. 23, 24, 26). It is difficult to determine the number of zoospores in each zoosporangium, but from several counts it is estimated that there are at least 128.

Several cases were observed in which definite zoospores became differentiated within the zoosporangium, but, owing to the failure of the wall to rupture, they were unable to escape (fig. 22). This was frequently found to occur if the conditions were suddenly changed just before the zoosporangium was mature. For this reason it was difficult to examine the actual discharge under the microscope, as the transfer of the filament from the beaker to a slide was sometimes sufficient to prevent liberation taking place. In other cases it was observed that the hole became stopped up by an emerging zoospore which was unable to pass through. Those remaining within the zoosporangium continued for some time to swim round the cell as though looking for some exit. A similar condition has been described by Atkinson (1916) in *Rhizophidium globosum*.

In one case which was watched the opening of the zoosporangium was just being formed. The first zoospore was observed pushing its way through the exit. It apparently experienced some difficulty in doing so—presumably the opening was a little small for it—and two hours elapsed before it was successfully liberated. Once it had escaped, the rest of the zoospores streamed

out in rapid succession. This condition is abnormal; usually liberation is sudden and rapid.

The zoospore after liberation is conical in shape (fig. 6) with a slight beak at the anterior end. There may or may not be a visible eyespot, but there are normally two granules in the clear region at the insertion of the two flagella. There are numerous chloroplasts which form a ring in the posterior part of the cell, leaving a clear area in the centre. These chloroplasts are connected together by protoplasmic threads. The whole protoplast shows a slow streaming movement. In several cases the chloroplasts were counted; from 10 to 15 were found.

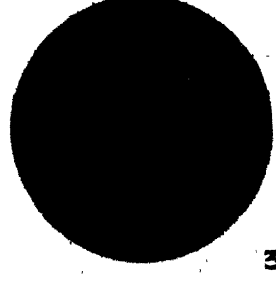
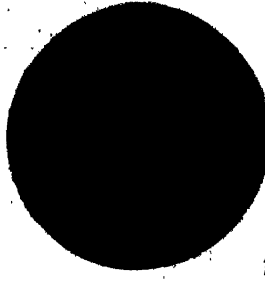
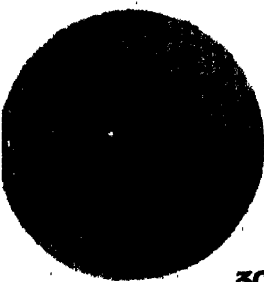
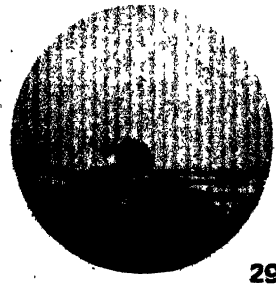
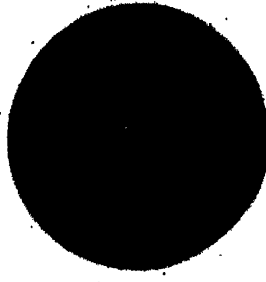
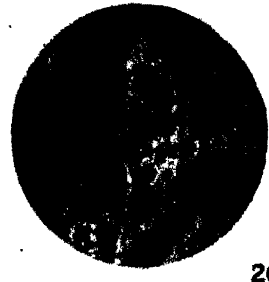
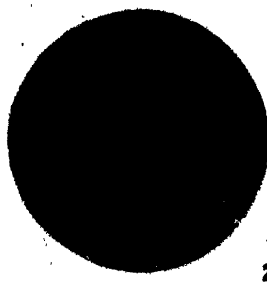
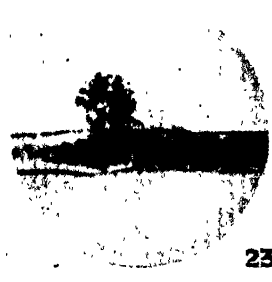
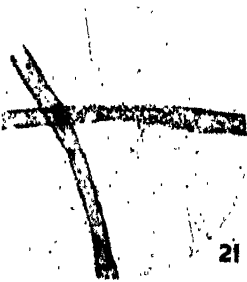
Each zoospore emerges backwards through the opening of the zoosporangium; about 75 % of them show a small granule attached to the twisted flagella. On emergence each zoospore turns sharply round and the granule is shaken off. The granule appears to be a portion of the residual cytoplasm of the zoosporangium. The movement of the zoospores is a rotation along the longitudinal axis.

Within about twenty minutes of liberation some of the zoospores commence to germinate; others continue active for from one to two hours. The zoospore become attached to the parent filament or near-by structure found associated with the liberated zoospores. It appears that the anterior end forms a little beak by which the zoospore attached itself (fig. 7). It elongates and the content of the zoospore seems to lose its definition, and staining shows that from two to five nuclei are present at this stage.

Elongation of the zoospore now commences (figs. 8 to 16) until the zoospore is as long as the parent cell. Then the first septum appears (fig. 17). These filaments derived from zoospores give the appearance of branching of the parent filament, but whereas a branch of a filament always originates directly beneath a septum (figs. 18, 19), zoospores may settle down anywhere along the length of the parent cell. Moreover, filaments originating from zoospores are finer and narrower than cells of the mature plant.

A study of the mature cell shows that when full grown it is much elongated. There is always a swelling developed at one side, just below or above the septum, which is very characteristic of this species. The swelling can occur at either end, and is much more pronounced in the older cells. The cell wall is thick and lamellated, showing a distant middle lamella and outer striations.

The structure of the chloroplast in the *Cladophoraceæ* has been studied by various workers. Carter (1919) came to the conclusion that there was a parietal film lining the cell wall which often became perforated or reticulated according to the relative abundance of the cell contents. It has been observed that a similar condition was found in a few cases, but when the alga was growing in diffuse daylight or in darkness, the chlorophyll appeared to be contained in numerous discoid chloroplasts each with a central pyrenoid. It has been suggested to us by Dr. Carter that the result of starvation would be the contraction of the chloroplast around the starch centres,



giving the impression of small separate discoid chloroplasts. The nuclei were not visible in the cells in a living condition, but after fixation and staining numerous ones were found in each cell associated with the chloroplasts.

The branching of the filaments was studied. A small protuberance occurs in the upper part of the cell immediately below a septum, the thick outer membrane is ruptured, and the branch initial is covered by the middle lamella of the parent cell, which is elastic. Usually at an early stage the branch is cut off from the parent cell by a septum. This septum is formed, as is well known, by the ingrowth of cellulose plates, like an iris diaphragm. The final closing of the hole is effected by the middle lamella, which grows inwards all round. This later becomes covered by cellulose.

SUMMARY.

1. Experiments have been conducted with two species of *Cladophora*, which show that there is a definite periodic response by the cells of the filament to alterations of aeration and nutrition. Zoospores are developed after five days' exposure to aeration; light of different colour has a retarding effect upon the periodicity. Continuous illumination under electric light adversely affects the alga, causing disorganisation of the cell contents.

2. The two species used show a remarkable uniformity in their response to the varying conditions of light, *C. glomerata* responding rather slower than *C. crispata*.

3. A study was made of the germination and subsequent development of the zoospores of *C. crispata*. The whole process was observed under the microscope and a series of drawings was made.

4. Observations on the structure of the chloroplast confirms the conclusions previously published.

Our thanks are due to Professor F. E. Fritsch for his kindness in determining the names of the two species of *Cladophora* used in this work, and also for much helpful advice. We wish also to thank Professor R. R. Gates for advice during the course of the experiments.

BIBLIOGRAPHY.

- ACTON, E. (1916).—"On the structure and origin of 'Cladophora Balls.'" *New Phyt.*, 15, 1-10.
- ANONYMOUS (1925).—Wratten light filters. Eastman Kodak Co.
- CANNON, H. G., and GROVE, A. J. (1927).—"An aeration and circulating apparatus for aquaria and general use." *Jour. Roy. Microsc. Soc.*, 47, 319-22.
- CARTER, N. (1919).—"The cytology of the Cladophoraceæ." *Ann. Botany*, 33, 467-78.
- KLEBS, G. (1896).—"Die Bedingungen der Fortpflanzung bei einiger Algen und Pilzen." Jena.
- KLUG, A. B. (1925).—"On the effect of light of different wave-lengths on the rate of reproduction of *Volvox aureus* and *Closterium acerosum*." *New Phyt.*, 24, 186-90.
- STRASBURGER, E. (1880).—"Ueber Zellbildung und Zelltheilung im Pflanzenreiche." Jena.

EXPLANATION OF PLATES.

PLATE I.

Fig. 1.—Part of a zoosporangium showing the swelling by which the zoospores will escape. The zoospores are seen aggregated around the opening.

Fig. 2.—A slightly later stage than Fig. 1.

Fig. 3.—The opening in the wall of the zoosporangium now formed and the zoospores emerging.

Fig. 4.—The opening completely formed. The zoospores are developing their flagella.

Fig. 5.—The appearance of the opening after the zoospores have been liberated.

PLATE II.

Fig. 6.—A mature zoospore showing the chloroplasts.

Fig. 7.—The zoospore developing a cell wall and the beak by which it will become attached.

Figs. 8-16.—Stages in the gradual growth of the zoospore and its attachment, the gradual increase in the number of the chloroplasts and the thickening of the wall.

Fig. 17.—Division of the zoospore into two cells by a septum. The base shows considerable thickening.

PLATE III.

Fig. 18.—A piece of a mature filament showing the formation of branches just below a septum.

Fig. 19.—A mature branch showing the way in which the basal cell of the branch displaces the upper cell of the original filament.

Fig. 20.—A zoosporangium drawn to show the characteristic swelling which is developed on one side. It is at this point that the opening will be formed.

PLATE IV.

Fig. 21.—Photomicrograph showing the character of a normal vegetative filament.

Fig. 22.—Photomicrograph showing a zoosporangium with zoospores which has not developed a normal opening to liberate them.

Figs. 23-24.—Photomicrographs showing the discharge of the zoospores from the zoosporangium taking place.

Fig. 25.—A very young zoospore which has rested on the parent filament.

Fig. 26.—Some zoospores which are growing while still associated with the zoosporangium.

Figs. 27-32.—Photomicrographs showing the germination of zoospores upon the parent filament, the attaching disc and the chloroplasts are clearly seen.

XII.—ON THE PEGIDIDÆ, A NEW FAMILY OF FORAMINIFERA.

By EDWARD HERON-ALLEN, F.R.S., F.R.M.S., and
ARTHUR EARLAND, F.R.M.S.

(Read June 6, 1928.)

THREE PLATES AND ONE TEXT-FIGURE.

THE history of the forms which we propose to describe commences over a century ago with the record of a species by d'Orbigny (1826). In his genus *Rotalia* the thirty-fourth species is listed as "*dubia*—habitat, Isle de France" (Mauritius). Nothing more; neither description nor figure was given, and we may assume from the specific name *dubia* that d'Orbigny had no very clear idea as to the precise nature of the organism which he had discovered. We know now that he had but a single specimen to work upon, and that not in the best condition, and his recognition of its rhizopodal nature and assignment to the genus *Rotalia*, not so very far from the position in which we now place it, is further evidence, if any were wanted, of the remarkable instinct for recognising rhizopodal structure which d'Orbigny possessed.

D'Orbigny did not refer again to his *Rotalia dubia* in any of his subsequent works, and, in the absence of figure and description, the species remained to all intents and purposes a *nomen nudum*, like so many more of the species listed in the "Tableau méthodique." It is true that the type specimen was in existence in Paris, together with some unfinished drawings of *Rotalia dubia*, intended to be later elaborated and to form part of one of d'Orbigny's "Planches inédites," but they do not appear to have been studied or considered to any extent except by Terquem and Berthelin, as noted by Heron-Allen and Earland (1915). The latter made tracings of most of d'Orbigny's outline sketches and bequeathed them, on his death, to Carlo Fornasini. These sketches formed the basis of Fornasini's invaluable series of papers on the d'Orbignian species in the "Tableau méthodique" (1826), and in one of these papers, published in 1908, will be found the solitary reference to *Rotalia dubia*. Fornasini writes: "It is difficult to give a satisfactory opinion, not merely on the specific, but even on the generic, value of this so-called *Rotalia*, in which the general aspect agrees with the valve of an *Ostracod*." In considering this judgment we must remember that Fornasini had not access to the original type specimen,

but only to a tracing made from an unfinished drawing, of which we annex a facsimile (text-fig. 1). On the evidence in his possession the judgment was not unreasonable. That this is the case is borne out by the fact that when we systematically examined the specimens in the "Tableau méthodique" collection in Paris in 1914, our note on the type was to the effect that the shell was worn and unrecognisable as any Foraminifer known to us, and might be an Ostracod. It must be borne in mind that the d'Orbigny types are mounted on small blue slips of card, each card being sealed up in a glass tube, which makes superficial examination very difficult.

Whilst examining Dr. J. J. Simpson's material from the Kerimba Archipelago off Portuguese East Africa, we found, in coral sand, a few organisms of two different types which could not be satisfactorily assigned to any known genus. These two types, which were evidently closely related,

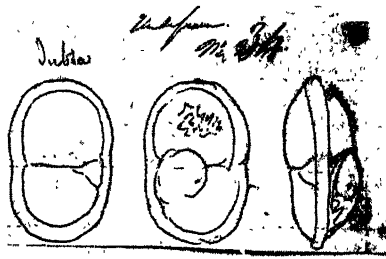


FIG. 1.—D'Orbigny's original sketch for drawing of *Rotalia dubia*.
(Reduced $\frac{1}{2}$ size.)

might be roughly described, respectively, as spherical and hemispherical. They occurred in only one of the many "samples" brought home by Dr. Simpson (labelled Station XI), and no definite locality could be given, as this "station" comprised a whole series of inshore reef gatherings in depths ranging from $\frac{1}{2}$ to 4 fathoms, between Manangoroshi Point and Lurio Point in Portuguese East Africa.

The appearance of the hemispherical type seemed vaguely familiar to us, and we eventually connected it with Fornasini's reproduction of Berthelin's crude tracing of d'Orbigny's sketch of *Rotalia dubia*, and remembered the specimen we had examined in Paris. By the kindness of Professor Marcellin Boule, the original type specimen was placed at our disposal, and the identification confirmed.* Moreover, a search through

* On revisiting the Collection for the purposes of this paper in April 1928, we found we were not able to photograph the specimen ourselves. A photograph made for us by the official photographer to the Museum gives only an indistinct view of half the superior surface of the test, and is useless for purposes of reproduction.

the specimens in our cabinet awaiting identification resulted in the finding of a somewhat similar specimen, picked out 25 years previously from one of the late Captain Seabrook's dredgings from the Java Sea (45 fathoms), and inquiry addressed to Mr. A. E. Harris, of Cardiff, elicited a further specimen from yet another locality, viz., Cebu, Philippine Islands. This had been found by his father, the late W. H. Harris, in another of Seabrook's dredgings. It thus became evident that the hemispherical type represented a new organism which, although very rare, was of wide distribution. Its affinities, however, were so problematical that we decided to await further material for diagnosis before publication, and in our Kerimba report we merely referred to the occurrence of *Rotalia dubia* and another form, and deferred comment on them to a later date.

The publication of this record brought us a communication from the late Joseph Wright, of Belfast, who reported that he had recently found *Rotalia dubia* in coral gravel from the Outer Anchorage, Mauritius, a most interesting occurrence in view of the fact that this island was d'Orbigny's original locality for his species. Wright sent us his specimens for examination in 1916, and we were not greatly surprised to find that he had both the hemispherical type (*Rotalia dubia*) and the spherical Kerimba type. Wright very generously gave us specimens and permission to use his material, but the War precluded any further immediate work on the subject.

There were many obstacles to the preparation of a description of the new types. The number of specimens available was very limited; the thickness of the shell wall, which is exceptional, precluded examination by transmitted light, and after one of the few specimens had been sectioned, without furnishing much information, an attempt at skiagraphy was made by Mr. J. F. Barnard, F.R.S. This was not as successful as we had hoped, owing to the difficulty of interpreting the orientation, in a spherical object, of the septa which the skiagraphs revealed.

And so, after several essays, the problem was gradually shelved, and the specimens might have remained undescribed indefinitely, but for two further discoveries:—

1. At Rarotonga another species of the spherical type was discovered. This was minute in size as compared with the Kerimba specimens, and could therefore be examined by transmitted light.

2. Another species of hemispherical type was found in one of the "Discovery" (1925-7) dredgings now in our hands for examination. The locality, viz., Annobon Island, in the Gulf of Guinea, is a factor of some zoological importance, because all previous records were confined to the Indo-Pacific.

These discoveries led to the resumption of work, encouraged as we were by the larger store of material now available. We had been convinced from the inception of the inquiry that the specimens represented a new genus, but we now realised that although the hemispherical and spherical

types were associated and clearly related, the relationship was not very close. It was originally thought that the hemispherical type developed in course of growth into the spherical. This theory did not survive, and we have been forced to the conclusion that while the spherical type passes through a hemispherical stage of growth, such early stage is not identical with the other hemispherical type found in the same material. In other words, the spherical type is probably derived from a hemispherical ancestor, but is now a distinct genus. We have therefore to deal with two genera, one based on *Rotalia dubia*, the hemispherical type, for which we propose the name *Pegidia*; the other, entirely new, and based on the Kerimba spherical type, for which we propose the name *Sphaeridia*. As the two genera do not appear to have any close relationship to acknowledged types, it will be necessary to institute a new family Pegidiidæ for their reception, and we shall take this opportunity of dealing with two other organisms which we regard as primitive types belonging to the new family. One of these, viz., *Physalidia*, is new to science; the other, *Rugidia*, is formed for the reception of an abnormal species which we originally described under the name of *Sphaeroidina corticata*. They resemble *Pegidia* and *Sphaeridia* in the character of the shell wall and the limited number and method of arrangement of the chambers, but differ in the simplicity of the tubular extensions which form their apertures.

The differences between *Pegidia* and *Sphaeridia*, as exhibited in the genotypes *Pegidia dubia* and *Sphaeridia papillata*, may be briefly summarised as follows :—

Sphaeridia papillata is covered with an exogenous ornament of rounded but prominent papillæ, while the ornament of *Pegidia dubia* consists of flat-topped, sharp-edged columns, giving a shagreen-like surface to the shell. Although *Sphaeridia* and *Pegidia* occur in the same gathering at both Kerimba and Mauritius, this characteristic differentiation of ornament is constant, and no specimen of *Sphaeridia* with *Pegidia* ornament has been found. Nor is it apparent how the majority of specimens of *Pegidia dubia* could by any extension of growth develop into a spherical form. Small specimens of *Pegidia dubia* appear to be identical in structure and development with the large specimens. Growth would appear, therefore, to be a matter of resorption and reconstruction on a larger scale. We know this to be the only means of growth in many Arenacea, and there is some evidence of the existence of this process in other groups, e.g., among the Lagenidæ, and in the small delicate final chamber often to be found in *Globigerina*, etc. A single specimen which is believed to be a partly developed individual of *Sphaeridia papillata* was found at Kerimba. Nothing similar has been found at Mauritius. This specimen is hemispherical, but the ornament is typical of *Sphaeridia*. Moreover, it has a single oral area of the characteristic *Sphaeridia* type, whereas *Pegidia dubia* has two visible oral areas situated at the opposite margins on the inferior side of the shell. It is noteworthy that *Pegidia pulvillus* from the Annobon locality, on the Atlantic side of the

African continent, has only a single oral area, and rounded but not prominent papillæ. So it seems probable that *Sphæridia papillata* is nearer in ancestry to the Atlantic type of *Pegidia* than to the Indo-Pacific type *Pegidia dubia*.

It is not easy to trace the affinities of *Pegidia* and *Sphæridia*. Obviously they have no very near relatives, while at the same time they possess features which suggest widely separated organisms. The shape and arrangement of the chambers are more Globigerine than Rotaline; but the nature and thickness of the wall suggest *Carpenteria* or some thick-walled *Pulvinulina*. The nature of the apertural area, however, is quite unique, and unless further researches reveal relationships at present unrecognisable, we think that these apertural characters alone are sufficient to justify the creation of a new family, the Pegididæ, which we regard as coming between the families Globigerinidæ and Rotalidæ in Brady's system.

The aberrant organism described by us from the Kerimba Archipelago (1915) under the name *Sphæroidina corticata* evidently represents a form allied to *Pegidia*, and is perhaps a stage in the evolution of the family. Its abnormally thick wall strengthened by rugosities bears a distinct resemblance to *Pegidia*, and we now recognise the presence of somewhat similar tubular processes in the apertural region which were formerly neglected as of no structural importance. On the other hand, the arrangement of the chambers is quite different, and we propose to make our species of 1915 the genotype of a new genus *Rugidia*.

So far as it is possible to theorise about the evolution of types of which we at present know so little, we offer the opinion that the Pegididæ represent an attempt, and, judging from their rarity, not entirely a successful attempt, to overcome the disadvantages attendant on the life of a free but minute benthic organism in waters subject to perpetual disturbance. The Kerimba and Mauritius gatherings are both from areas and depths where the tidal current keeps all minute particles in ceaseless agitation. The bottom consists of coral gravel, i.e. worn-down fragments of poyzoa, mollusca, etc. Foraminifera have a struggle to survive under such conditions, though food is plentiful. Protection is sought by a thickening of the shell wall, a very noticeable feature in many of the Foraminifera which affect such deposits as these (cf. *Amphistegina*, *Textularia rugosa*, etc.). A further gain would be achieved by the assumption of a spherical form, rolling freely with the current, and increased by the evolution of the solid papillæ which reduce the surface of contact and friction. The aperture is always one of the most vulnerable points in the armour of Foraminifera, and we recognise many and varied efforts to defend it in different genera. In *Pegidia* and *Sphæridia* we get almost as far as possible towards the abolition of the aperture, for a solid block of shell substance pierced by numerous branching tubes for the protrusion of the protoplasm has taken the place of the comparatively large apertures characteristic of most Globigerinidæ and many Rotalidæ. The animal enjoys all the advantages of a large apertural area without those risks of fracture, of obstruction by foreign bodies, or of

attack by parasites to which a larger aperture renders the organism liable.

The wide distribution of the family in tropical seas would appear to connote a prolonged ancestry. Geological records at present give no evidence on this point so far as our own information goes. It is possible that early stages of the family's evolution may yet be found in tropical deposits, but, on the other hand, it must be recognised that coral sands and gravels such as the family now favours do not readily lend themselves to fossilisation.

Family—PEGIDIDÆ, fam. nov.

Test free, calcareous, perforate, thick-walled, lenticular or sub-spherical in form. Chambers turgid but few in number, rarely more than three or four in the adult shell, arranged so that each successive chamber is opposed to or partly enveloping its predecessors. Initial chambers either arranged spirally or in opposition, and resorbed in course of growth. Aperture tubular or a series of tubes, either free or perforating a solid mass of shell substance filling up the depression between the final chambers. No canal system.

PHYSALIDIA,* gen. nov.

Test free, calcareous, coarsely perforate, thick-walled, smooth, consisting of a few sub-globular chambers arranged in opposition. Aperture one or more rudimentary tubes at the line of opposition of chambers, sometimes accompanied by a thickening of shell deposit at this point.

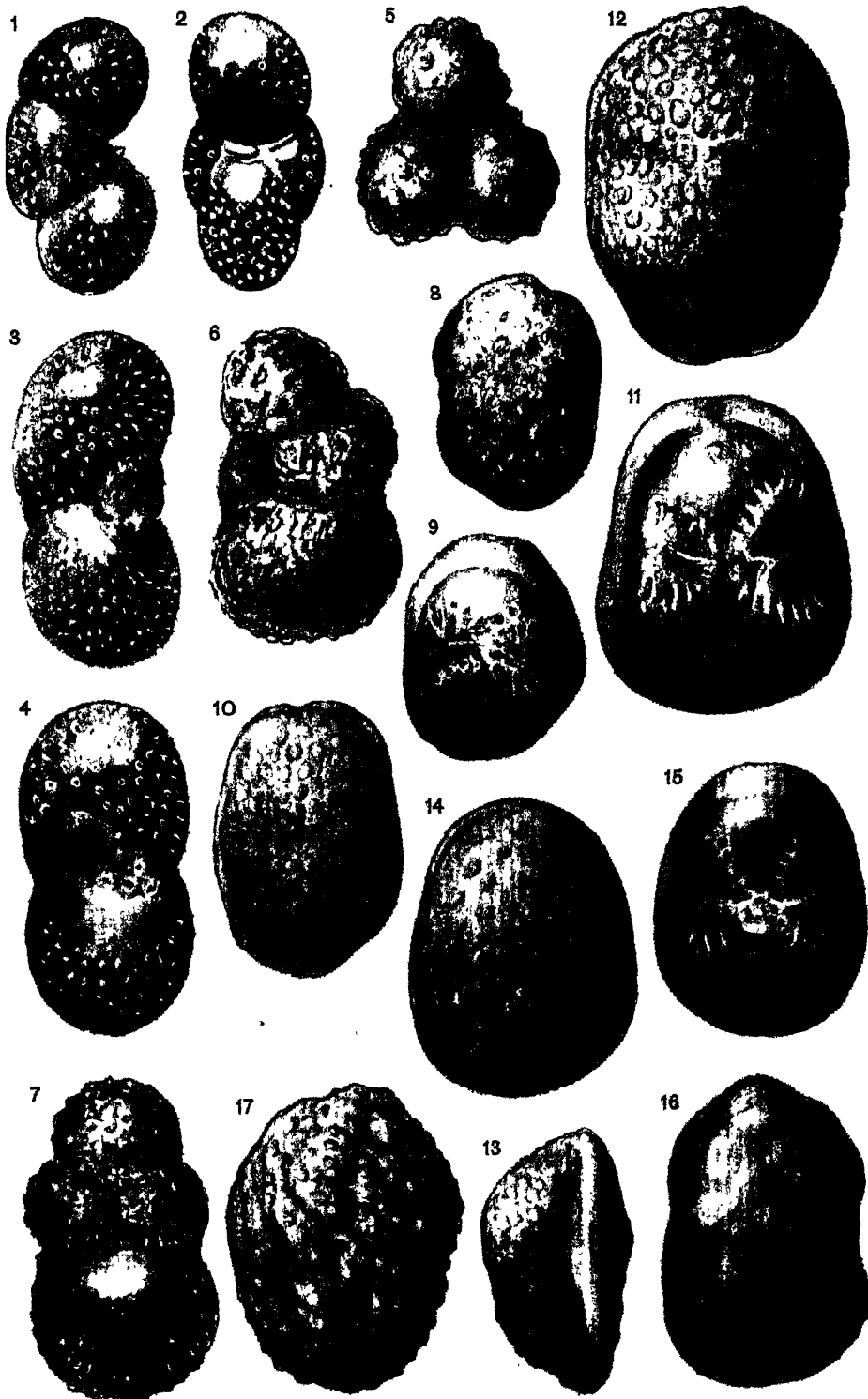
The genus is founded with some diffidence for the reception of two specimens evidently closely related though specifically distinct. They appear to represent the most primitive condition of the Pegididæ, and are clearly specific organisms, not abnormal varieties of a type. Owing to the rarity of all the Pegididæ, further details may not be forthcoming in the near future.

PHYSALIDIA SIMPLEX, sp. nov.

PLATE I. FIGS. 1 AND 2.

Test free, calcareous, smooth, consisting of three sub-globular chambers arranged in a curved line and separated by deep septal grooves. Aperture a short lipped tube on inner edge at mid point of the inner curve, where the three chambers are contiguous. The middle chamber is larger than the end ones. No connection has been traced between the chambers, and the order of their succession is uncertain. The surface of the shell is smooth and glassy and sparsely covered with somewhat coarse tubulation, except over a limited area on the inner curve of the terminal chamber opposed to the one bearing the aperture, where the shell substance appears to be

* *φυσαλὶς* = a bubble.



thicker than elsewhere and free from tubulation. The shell wall is not abnormally thick except in the septal areas.

A single specimen of this curious organism from Rarotonga, $4\frac{1}{2}$ fathoms.

Measurements.—Length 0.3 mm. Breadth of middle chamber 0.16 mm.

Type in the Heron-Allen and Earland Collection, British Museum.

PHYSALIDIA BICAMERATA, sp. nov.

PLATE I. FIGS. 3 AND 4.

Test free, calcareous, thick-walled, smooth and coarsely tubulated, shaped like a short cylinder with rounded ends and slight median constriction, consisting of two apparent chambers only which are placed in opposition. The first chamber is an ovate spheroid, while the second is like a deep cup on which the first rests obliquely, their line of junction being plainly marked by a sutural depression which is more apparent on one side of the cylinder than on the other. This side, which, by analogy with *Pegidia*, represents the inferior or ventral surface of the shell, is marked by a smooth area free from coarse tubulation on the inner margin of the first chamber and by a thickening of the shell substance on the inner margin of the second chamber, through which thickened area, when examined by transmitted light, a few tubes forming the aperture can be seen to pass. When examined by transmitted light, the portion of the first chamber devoid of coarse tubulations appears dark in colour and seems to be cut off from the rest of the sphere by a definite septum. The colour is presumably due to chitinous remains of an earlier chamber or chambers which have been resorbed.

A single specimen from Papeete, shallow water. In superficial appearance, especially in the nature of its tubulation, it conveys a distinct suggestion of *Sphaeroidina*, but there can be no doubt as to the generic distinction of the organism.

Measurements.—Length 0.52 mm. Breadth 0.28 mm. Type in Heron-Allen and Earland Collection, British Museum.

RUGIDIA,* gen. nov.

PLATE I. FIGS. 5, 6 AND 7.

Genotype.—*Sphaeroidina corticata* H.-A. and E. (Trans. Zool. Soc. Lond., 1915, 20, pt. xvii, 681, pl. LI, figs. 14-18.) In the Heron-Allen and Earland Collection, British Museum.

Supplementary and Amended Description.—Test free, calcareous, perforate, thick-walled, the adult shell exhibiting only four sub-globular chambers arranged in opposed pairs, all visible and forming an irregular oval, compressed on two faces. Walls thick, coarsely punctate and covered with irregular cortications giving a rough bark-like appearance to the test,

* ruga = a wrinkle.

especially on the more convex or superior side. Smoother on the inferior side, especially in the fissure between the points of opposition of the final and penultimate chambers. This fissure and the depression between the final and the earlier pairs of chambers is more or less filled with shell matter, through which numerous short tubes, constituting the apertures, pass. There is, however, no solid plug of shell substance filling the depression as in *Pegidia* or *Sphæridia*.

In addition to the localities previously given (*op. cit.*), we have records of *Rugidia corticata* from Rarotonga (4½ fathoms), and it is evidently widely distributed in the Indo-Pacific area, though always very rare.

We figure an immature specimen from Rarotonga exhibiting three chambers only. As none of our adult specimens show any sign of similar early development when examined by transmitted light, but consist of four large chambers only, it appears evident that growth is effected by resorption of the initial growth and replacement by larger chambers.

PEGIDIA,* gen. nov.

Test free, calcareous, perforate, thick-walled; chambers three to four in number, arranged in opposition and separated by thick septa, forming an ellipsoid or nearly circular and unequally biconvex test. Aperture a series of furcating tubes passing through a solid mass of shell substance filling up the depression between adjacent chambers near one edge of the inferior or less convex side of the test.

Genotype.—*Rotalia dubia* d'Orbigny, 1826, in the Laboratoire de Paléontologie attached to the Musée de l'Histoire Naturelle in Paris.†

Paratypes in the Heron-Allen and Earland Collection in the British Museum and in the Joseph Wright Collection, National Museum of Ireland.

PEGIDIA DUBIA (d'Orbigny).

PLATE I. FIGS. 8-15.

Rotalia dubia d'Orb.—D'Orbigny, 1826, Ann. Sci. Nat. Paris, 7, 274, No. 34.

Rotalia dubia d'Orb.—Fornasini, 1908, Mem. Acc. Sci. Ist. Bologna, S. 6, 5, 46, pl. I, fig. 14.

Rotalia dubia d'Orb.—Heron-Allen and Earland, 1915, Trans. Zool. Soc. Lond., 20, 546.

Test free, thick-walled, perforate, unequally biconvex and of variable shape, ranging in contour between a regular oval and a quadrate figure with rounded-off corners. The superior face is highly convex in the centre, sloping to the peripheral edge, which is flat or even slightly recurved; no visible sutural lines on the superior face, which is densely covered with

* *πηγὸς* = thick, solid.

† See footnote on p. 284.

sharp-edged tubercles, giving a "shagreened" appearance to the test. The inferior surface is less convex, sloping gently to the rounded periphery, hyaline and smooth except for the presence of a few grooves radiating from the open ends of the tubes in the oral area. Traversing the inferior surface, across its shorter diameter, and separating the shell into two nearly equal halves, is a slight median depression which marks the position of an internal septum.

The test appears to consist of three chambers only. The earliest chamber is large and spherical, the second is kidney-shaped and to a considerable extent envelopes the first chamber. The third chamber is also kidney-shaped and opposed to the earlier two, from which it is separated by a thick septum, the position of which is marked externally by the median depression on the base already referred to. The chambers communicate with the exterior by means of furcating tubes passing obliquely through a mass of glassy shell substance which fills up the depressions between the inflated chambers. These tubes are visible externally through the thick shell substance in the form of pairs of chevrons, whose apices form the central point of the base. Presumably one chevron represents the oral aperture of the final and the other the aperture of the penultimate chamber.

The first chamber is frequently resorbed, leaving only a dark chitinous mass visible. Indeed, as the same number of chambers—three—appears to characterise all the specimens irrespective of size or age, it would seem that growth is effected by resorption and reformation of the chambers, and not, as usually, by the addition of new chambers.

The locality for d'Orbigny's type of *Rotalia dubia* was Ile de France (Mauritius), and that island is the only locality where the species can be described as occurring with any frequency. Joseph Wright obtained in all nearly a dozen specimens from some nine ounces of material from the "Outer Anchorage." The depth is unknown, but certainly only a few fathoms. Wright described the material as "gravel" with no fine material, but containing in profusion mollusca and foraminifera, mostly worn and broken. Apart from Mauritius, we found a very few specimens at Station XI, Kerimba Archipelago, East Africa, a station covering a series of inshore reef gatherings between Manangoroshi Point and Lurio Point ($\frac{1}{2}$ fathom to 4 fathoms), and single specimens are in our collection from Java Sea (45 fathoms), and Cebu, Philippine Islands (45 fathoms). The species is therefore widely distributed in the Indo-Pacific area.

Pegidia dubia varies considerably in size. A series of measurements gives the following range:—

	Minimum.	Maximum.
Length	0.62 mm.	1.25 mm.
Breadth	0.55 mm.	1.05 mm.
Thickness or Height (average specimen)	0.60 mm.	

PEGIDIA DUBIA var. LÆVIGATA, var. nov.

PLATE I. FIG. 16.

In the Kerimba material we found a specimen characterised by the entire absence of the typical "shagreen" secondary growth from the superior surface, which is of a dull whitish colour and quite smooth except for a few irregular lines of depression not connected with the internal structure. The inferior surface is quite typical. It is a characteristic variation, and we figure the dorsal surface for purposes of future identification.

Measurements.—Length 0.52 mm. Breath 0.86 mm. Type in the Heron-Allen and Earland Collection, British Museum.

PEGIDIA DUBIA var. ORNATA, var. nov.

PLATE I. FIG. 17.

The solitary specimen of *Pegidia dubia* from Cebu, Philippine Islands, 45 fathoms differs from the type in the character of the markings on the superior surface, which are more regularly papillate and arranged in irregularly grouped areas separated by distinct lines of depression. The inferior surface is typical. The specimen, of which we figure the dorsal aspect, seems worthy of distinction. It is probably only a local variation, but may eventually prove to be a distinct species.

Measurements.—Length 0.72 mm. Breath 0.60 mm. Type in the Heron-Allen and Earland Collection, British Museum.

PEGIDIA PULVILLUS,* sp. nov.

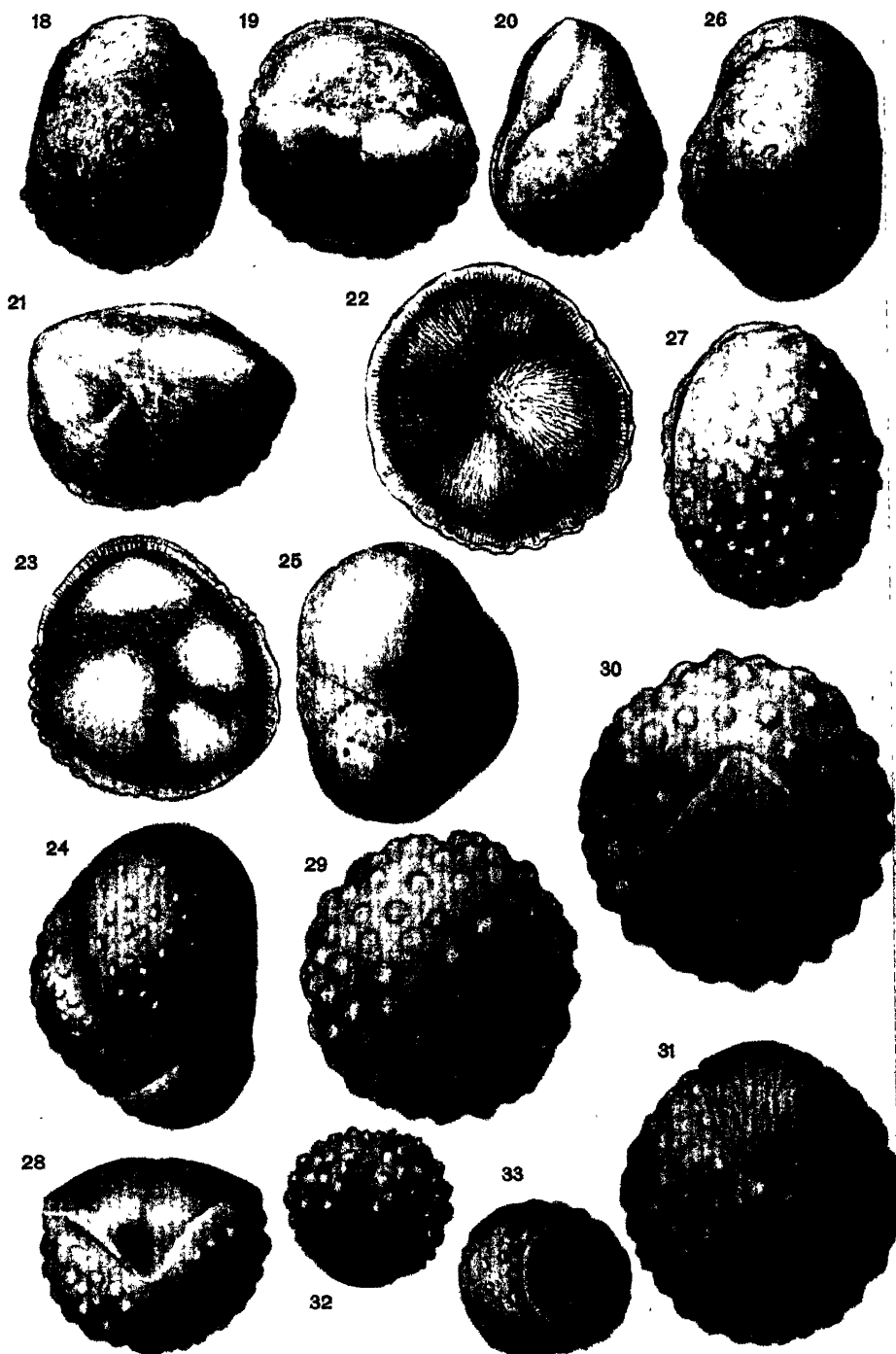
PLATE II. FIGS. 18-23.

Test free, thick-walled, perforate, unequally biconvex, consisting of four chambers only. The superior face, which is nearly circular in contour, is domed at the aboral edge, sloping gradually towards the edge of the last-formed chamber. Its surface is rough and covered with tubercles and ridges, the position of which, to some extent, indicates the position of the chambers, although the sutural lines are very feebly indicated except at the last chamber, which is not so densely covered with exogenous growth as the others.

The inferior surface is less convex, and very hyaline in contrast with the superior surface, which is white and opaque owing to the number and size of the tubules piercing its wall. Although the sutural lines are almost flush on the base, they are very distinguishable, as also are the position and shape of the chambers, owing to transparency of the thick basal wall.

The arrangement of the first three chambers is the same as in *P. dubia*; the fourth chamber is narrower and placed at right angles to the septum,

* Pulvillus is a little cushion.



which divides the third from the earlier chambers. The fourth chamber is thus contiguous to all its predecessors, and is probably in communication with all of them. The aperture consists of a number of tubes ramifying through a plug of solid shell substance which fills in the space between the point of junction of the chambers, at the centre of the base, and the forward edge of the last chamber. There is only one series of tubes visible in this species, and not two as in *P. dubia*.

Rare at "Discovery" Station 283, off Annobon Island, Gulf of Guinea, 18-80 metres, a coral sand characterised by predominance of *Amphistegina*. We have to thank Dr. Stanley Kemp, the Director, and the "Discovery" Committee for permission to publish this preliminary notice of an interesting record.

Measurements.—Length 0.70 mm. Breadth 0.70 mm. Height 0.55 mm. Types in the Heron-Allen and Earland Collection, British Museum.

PEGIDIA CULEBRÆ, sp. nov.

PLATE II. FIGS. 24, 25, 26.

Test free, thick-walled, perforate, roughly oval in plan from whatever lateral point of view. The superior face highly domed towards one edge, less convex at the other, and sparsely covered with small tubercles of shell substance; the inferior less convex and smooth. Sutural lines well marked but not deeply depressed, clearly indicating the number and position of the chambers. These are three in number. As seen on the superior face they appear of very unequal size, the first formed chamber occupying more than half of the total surface. This is apparently due to a thick deposit of shell substance covering it and filling up the depressions between it and the later chambers. On the inferior side there is less disparity. The central area of the inferior side is occupied by a solid mass of shell substance through which the characteristic tubes pass to the exterior. They are less numerous and prominent than in the other species, but extend towards and round the curve of the edge along the sutural line.

The shell wall is enormously thick, especially on the superior side. There is no hyaline shell wall on the inferior side as in the other species, the shell being uniformly white owing to the tubulation.

Only a single specimen is known to us, which was found in material from the "Challenger" Station 24, Culebra Island, off St. Thomas, West Indies (890 fathoms), and we should hesitate before describing it as a new species but for the marked differences which it presents both in appearance and habitat. While referring it to *Pegidia*, we recognise that in its sub-spherical shape and shell wall it has affinities with *Sphæridia*. It may represent an Atlantic modification of that type as affected by the greater depth at which it was found.

Measurements.—Length 1.23 mm. Breadth 0.93 mm. Height 0.90 mm. Type in the Heron-Allen and Earland Collection, British Museum.

SPHÆRIDIA, gen. nov.

Test free, calcareous, thick-walled, perforate, very nearly spherical. Chambers few, three to four in number, rapidly increasing in size, opposed to and nearly enveloping each other. Aperture a series of furcating tubes passing through a large and solid mass of shell substance which fills in the gap between the final and penultimate chambers and thus rounds off the sphere.

SPHÆRIDIA PAPILLATA, sp. nov.

PLATE II AND III. FIGS. 27-37.

Test free, thick-walled, perforate, nearly spherical in shape and usually without apparent sutural lines. The whole sphere covered with coarse hemispherical beads or papillæ of clear shell substance except over an area which represents the position of the oral aperture. This oral area is extensive and heart-shaped and raised slightly above the general level of the sphere. It occupies by estimate nearly a quarter of the external surface of the sphere and is a solid mass of shell substance perforated by numerous wide-mouthed furcating tubes which form the communications between the interior chambers and the exterior of the shell. Diameter of sphere 0.7 — 0.85 mm.

So far as can be ascertained from the few specimens at our disposal, the shell consists of a few chambers only, probably three or at the most four.

A single immature specimen was found in which the stages of growth can be studied. This specimen, which we figure, resembles *Pegidia dubia* and *Pegidia pulvillus* in many respects, but is distinguishable owing to the rounded nature of the papillæ and the character of the oral area. Its first chamber is spherical, about 0.15 mm. in diameter, and largely enveloped by the second chamber, which is about 0.4 mm. in diameter. The two combined occupy a quarter of a sphere. Opposed to these first two chambers, and separated from them by a thick septum, is the third chamber, which is a rounded quarter-segment of a sphere, and so completes a hemispherical test having a thick hyaline base with rounded edges, which at the next stage will form an internal septum dividing the full-grown sphere into two unequal halves. In the young specimen this next stage is seen (by transmitted light) in process of growth. It is a long tubular cavity curved half-way round its predecessors and communicating with the exterior and with the earlier chambers by means of branching tubes passing through a solid mass of shell substance. There is only one such series of tubes at one edge of the specimen, not a series at opposite edges as in *Pegidia dubia*. This tubular cavity will develop into a large hemispherical chamber, opposed to the earlier three and so completing a spherical test.

A broken specimen shows that the internal wall of the sphere is smooth except for slight ridges which may represent vestiges of chambers which have been resorbed. Such resorption and reconstruction of the shell wall

is probably an important feature in the growth of the shell. As already stated, no sutural lines are visible, but one or two specimens have been found in which the spherical form is less pronounced than usual. They also exhibit depressed lines girdling the test, evidently marking the position of an internal septum which would be hardly noticeable but for wider spacing of the papillæ along these lines. It is presumed that these specimens are of incomplete growth and that a further chamber will be developed in due course involving the resorption of a large part of the existing wall, thus bringing the individual into normal spherical form.

The thickness of the shell wall is considerable, but varies in the same individual according to its position, being at its thinnest at the point farthest from the oral area. Measurements of the broken specimen give a thickness varying between

Sphæridia papillata is evidently very rare. Four developed specimens and one immature were found by us at Station XI, Kerimba Archipelago. Wright found five or six specimens at Mauritius.

Genotypes in the Heron-Allen and Earland Collection in the British Museum and in the Joseph Wright Collection, National Museum of Ireland.

SPHÆRIDIA RUGATA, sp. nov.

PLATE III FIG. 38-43.

Test free, minute, thick-walled, perforate, nearly spherical in shape, one pole of the sphere being slightly produced into a rounded mass. The spherical portion represents the final chamber of the test, while the protruding mass is formed by the upper surfaces of the earlier chambers. These appear to be 3-5 in number, rapidly increasing in size and arranged in a trochoid spiral. The penultimate chamber, which is almost entirely enclosed by the ultimate chamber, is sub-globose, and when present more than half fills the sphere, but is usually resorbed, leaving only a chitinous membrane to show its position.

The spherical final chamber has the whitish appearance of frosted glass, which is seen under a high power to be due to minute wrinkles or corrugations of the surface. Between these corrugations, which vary in prominence in different specimens, lie the tubuli, which are coarse and, owing to the thickness of the shell wall, a prominent feature in balsam-mounted specimens. The sutural line between the sphere and the earlier chambers is distinct and hyaline, as also is the protruding mass of early chambers. The aperture consists of a series of short tubular openings in the sutural line extending almost round the test.

The thickness of the shell wall is altogether disproportional to the size of the test :

Greater diameter	..	..	..	..	0.18-0.24 mm.
Lesser diameter	..	..	..	..	0.16-0.19 mm.
Thickness of wall	..	..	..	..	0.02 mm.

Sphaeridia rugata occurs in material from Rarotonga, Cook Islands, South Pacific (depth $4\frac{1}{2}$ fathoms), and is presumably not uncommon there, as about a dozen specimens were found in a few c.c. of material otherwise quite typical of the latitude and depth. It will no doubt be found to have a wide range in the Indo-Pacific region, as a single specimen was found in 1913 at Station XI, Kerimba Archipelago, Portuguese East Africa. This specimen is slightly larger than those from Rarotonga (lesser diameter 0.26 mm.), but is otherwise typical. Types in the Heron-Allen and Earland Collection, British Museum.

ADDENDUM.

Since 1914 we have been on the alert for species which might be regarded as related or ancestral to *Pegidia*, without any definite results. It may, however, be helpful to other workers if we figure two different forms, hitherto undescribed, which were at first regarded as allies. Investigation showed that the resemblance was merely superficial and that their internal structure was conformable to accepted generic types.

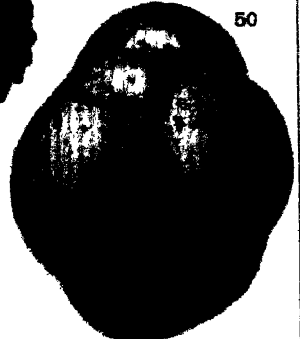
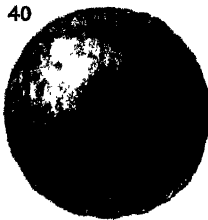
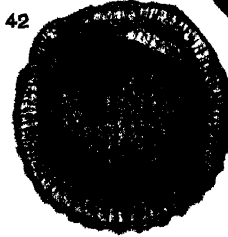
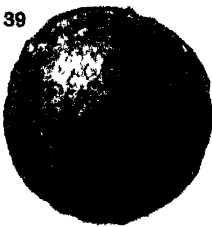
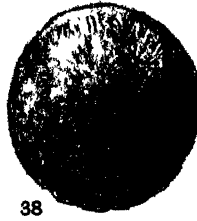
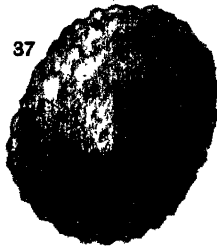
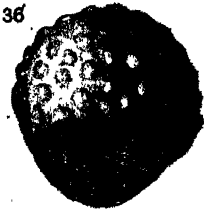
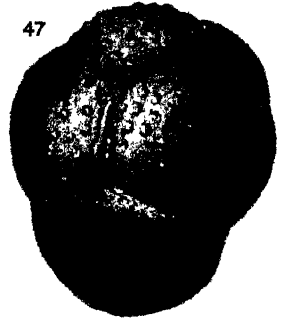
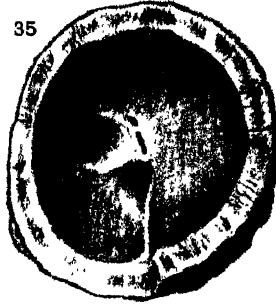
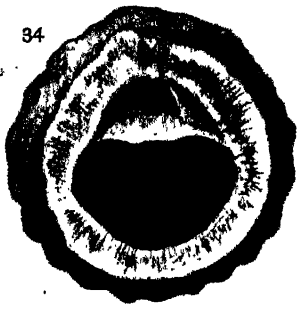
PULVINULINA CORTICATA, sp. nov.

PLATE III. FIG. 44, 45, 46.

Test free, calcareous, thick-walled, plano-convex with rounded edge, consisting of five or six large and irregularly shaped chambers in a low trochoid spiral, separated by abnormally thick septa. A broad stolon tube, which does not follow the usual shortest path between adjacent chambers, runs between the median points on the inner edge of the chambers. The stolon is thus often as long as the chambers it links. The aperture is a small curved slit situated on the convex or ventral side at the inner edge of the final chamber. The ventral side and the greater part of the plane or dorsal side is covered with ridges of secondary shell matter arranged in irregular hexagons. At the bottom of each pit so formed a stout tubule terminating in a nipple-shaped orifice communicates directly with the adjacent chamber cavity. The dorsal side of the test from the apertural edge to the middle of the shell is smooth and thick-walled, and the central point is generally marked by a deep pit which may indicate a sessile condition of the organism when young. Owing to the thickness of the wall and ornament, no septation or internal structure is visible unless the specimens are examined by transmitted light.*

Measurements.—Length, 0.25–0.3 mm.; breadth, 0.2 mm.; height, 0.15 mm.

* A convenient method of carrying out such an investigation where it is not desired to mount the specimen permanently in balsam is to immerse it in carbol-xylo. This can afterwards be washed out with alcohol and the specimen recovered without injury.



Pulvinulina corticata occurs very rarely at Kerimba Station XI in company with *Rugidia corticata*, and was at first regarded as the immature stage of that species. The absence of any rotaline initial chambers in *Rugidia*, and the subsequent discovery of immature *Rugidia* similar in structure to the adult shell, has compelled us to abandon the theory of their identity, and their occurrence in the same gathering can only be regarded as a coincidence.

Pulvinulina corticata has not been found by us at any other locality. It seems probable, however, that the specimen figured by Cushman in his "Samoa Foraminifera" (Department of Marine Biology of the Carnegie Institution of Washington, 1924, 21, p. 42, pl. xiii, figs. 7-8) and assigned (with reservations) to *Pulvinulina favus* Brady may be *P. corticata*, to which the figure has a greater resemblance than to Brady's species. If the identity is accepted, it demonstrates that *P. corticata* ranges right across the Indo-Pacific region and may be looked for in suitable material from any point in that area. Types in the Heron-Allen and Earland Collection, British Museum.

PULVINULINA DECIPIENS, sp. nov.

PLATE III. FIG. 47-50.

Test free, calcareous, thick-walled but finely tubulated, dull white in colour, biconvex to subspherical in shape, consisting of one and a half to two convolutions, each of about four or five rather turgid chambers, the later ones rapidly increasing in size. Old specimens tend to add irregular sub-globular chambers which conceal the rotaline plan of growth.

The dorsal surface is covered with a deposit of secondary shell substance studded with small rounded papillæ, less prominent on the final chambers. The septation is obscured except the spiral suture and the septal lines of the last few chambers.

The ventral surface is smooth and exhibits only the chambers of the last convolution, separated by well-marked septal depressions. The only aperture in the adult shell is a series of coarse round holes dotted over the inner half of the final chamber and the adjacent septal lines on the ventral side, but sections show that in the young shell there is a well-marked oral aperture in the form of a loop-like slit on the inner edge of the chambers.

Measurement of Large Normal Specimens.—Length, 1.2-1.8 mm.; breadth, 1.2-1.4 mm.; height, 0.8 mm. Large specimens with abnormal final chambers are considerably larger.

Pulvinulina decipiens occurs in some numbers in a small sample of material from Station 2415, U.S. Fish Commission steamer "Albatross," 30° 44' N. 79° 26' W., off Georgia (440 fathoms). We have not seen it elsewhere, but it is clearly related to the group of *Pulvinulina repanda* (Fichtel and Moll), which species has a somewhat similar series of sieve-like apertures.

At first sight *Pulvinulina decipiens* bears an extraordinary resemblance to *Pegidia culebræ*, owing to its white colour, turgid chambers, ornament of papillæ and sieve-like oral apertures. But except in the abnormal specimens, even the most casual examination cannot fail to notice the differences in structure, which in the case of abnormal specimens is exposed on fracture or section. Types in the Heron-Allen and Earland Collection, British Museum.

REFERENCES.

- d'ORBIGNY (1826).—"Tableau méthodique de la classe des Cephalopodes." Ann. des Sci. Nat., 7, 274.
 FORNASINI (1908).—Mem. Acc. Sci. Inst. Bologna, 5, 46, pl. 1, fig. 14.
 HERON-ALLEN and EARLAND (1915).—On the d'Orbigny Collection. "Planches inédites." Trans. Zool. Soc. London, 20, 544.
 HERON-ALLEN and EARLAND (1915).—*Ibid.* 20, 681 (pl. li, figs. 14-18).

EXPLANATION OF PLATES.

PLATE I.

- Fig. 1.—*Physalidia simplex* sp. nov. Lateral view. $\times 120$.
 Fig. 2.— " " " " Front or oral view. $\times 120$.
 Fig. 3.—*Physalidia bicamerata* sp. nov. Lateral view. $\times 90$.
 Fig. 4.— " " " " Oral view. $\times 90$.
 Fig. 5.—*Rugidia corticata* (Heron-Allen and Earland). Young individual. $\times 150$.
 Fig. 6.— " " " " Dorsal view. $\times 95$.
 Fig. 7.— " " " " Oral view. $\times 90$.
 Fig. 8.—*Pegidia dubia* (d'Orbigny). Young individual, dorsal view. $\times 45$.
 Fig. 9.— " " " " oral view. $\times 50$.
 Fig. 10.— " " " " Adult, dorsal view. $\times 30$.
 Fig. 11.— " " " " " ventral view. $\times 40$.
 Fig. 12.— " " " " " dorsal view. $\times 40$.
 Fig. 13.— " " " " " edge view. $\times 35$.
 Fig. 14.— " " " " " dorsal view. $\times 45$.
 Fig. 15.— " " " " " ventral view. $\times 40$.

NOTE.—The series figs. 8-13 are drawn from Mauritius specimens, figs. 14, 15 from Kerimba Archipelago.

- Fig. 16.—*Pegidia dubia* var. *laevigata* var. nov. Dorsal view. $\times 80$.
 Fig. 17.— " " var. *ornata* var. nov. Dorsal view. $\times 60$.

PLATE II.

- Fig. 18.—*Pegidia pulvillus* sp. nov. Dorsal view. $\times 50$.
 Fig. 19.— " " " " Ventral view. $\times 50$.
 Fig. 20.— " " " " Lateral edge view. $\times 50$.
 Fig. 21.— " " " " Frontal edge view. $\times 50$.
 Fig. 22.— " " " " (by transmitted light). Dorsal view. $\times 60$.
 Fig. 23.— " " " " Ventral view. $\times 60$.
 Fig. 24.—*Pegidia culebræ* sp. nov. Dorsal view. $\times 35$.
 Fig. 25.— " " " " Ventral view. $\times 32$.
 Fig. 26.— " " " " Edge view. $\times 32$.
 Fig. 27.—*Spheredia papillata* sp. nov. Young stage, dorsal view. $\times 80$.
 Fig. 28.— " " " " frontal edge view. $\times 55$.
 Fig. 29.— " " " " Adult, aboral view. $\times 60$.
 Fig. 30.— " " " " oral view. $\times 65$.
 Fig. 31.— " " " " lateral-oral view. $\times 60$.
 Fig. 32.— " " " " Young individual showing area free from papillæ marking line of an internal septum. $\times 35$.
 Fig. 33.— " " " " Lateral-oral view of young individual. $\times 35$.

PLATE III.

- Fig. 34.—*Sphæridia papillata* sp. nov. Ground down to show the principal internal septum and remains of another resorbed septum. NOTE.—The thickness of the shell wall is somewhat exaggerated by the angle at which the section is ground. $\times 60$.
- Fig. 35.— " " " " A broken specimen showing the principal septum, traces of other resorbed septa, and in centre tubes communicating with the earlier chambers. $\times 65$.
- Fig. 36.— " " " " Lateral-oral view of young specimen. $\times 35$.
- Fig. 37.— " " " " Abnormal oval specimen, much waterworn, looking down on oral area. $\times 30$.
- NOTE.—Figs. 27–31 and 34 are drawn from specimens from Kerimba, and figs. 32, 33 and 35–37 from Mauritius.
- Fig. 38.—*Sphæridia rugata* sp. nov. Lateral-oral view. $\times 136$.
- Fig. 39.— " " " " " " " " " " " $\times 136$.
- Fig. 40.— " " " " Superior view. $\times 136$.
- Figs. 41, 42.—" " " " (by transmitted light). Showing internal septa and chitinous remains of resorbed internal chambers. $\times 145$.
- Fig. 43.— " " " " A fragment showing oral tubes. $\times 320$.
- Fig. 44.—*Pulvinulina corticata* sp. nov. Dorsal view. $\times 100$.
- Fig. 45.— " " " " Ventral view. $\times 115$.
- Fig. 46.— " " " " Edge view. $\times 110$.
- Fig. 47.—*Pulvinulina decipiens* sp. nov. Dorsal view. $\times 27$.
- Fig. 48.— " " " " Ventral view. $\times 27$.
- Fig. 49.— " " " " Edge-oral view. $\times 27$.
- Fig. 50.— " " " " An old and irregularly grown individual with supplementary chambers. $\times 27$.

A REVIEW
OF
RECENT WORK ON MICRO-DISSECTION AND MICRO-
INJECTION OF LIVING PROTOPLASM.

By JOAN LATTER, Ph.D., F.L.S.

THE use of the mechanical pipette holder and moist chamber, first devised by Barber and Burrows in 1907, has opened up a widely spreading field of biological inquiry. Further elaboration of the technique soon facilitated the manipulation of fine glass needles and pipettes in the field of high magnifications of the compound microscope. The method was originally used almost exclusively for isolating micro-organisms, and was first applied to the study of the physical properties of protoplasm by Kite in 1912. Since that year the micrurgical technique has been extensively used and many of its possibilities demonstrated, chiefly by Dr. Robert Chambers and his colleagues at Cornell University Medical College and the Marine Biological Laboratory at Woods Hole.

The technique of micro-dissection naturally lends itself to the study of animal tissues rather than those of plants, whose cellulose walls render penetration by the micro-dissection needle a difficulty. Echinoderm eggs and species of *amœbæ* are favourite subjects for study by this technique, particularly for micro-injection work, which is probably the most important line along which this branch of inquiry has developed.

Results obtained by the micro-dissection method up to 1924 are fully described by Dr. Chambers in his account of "The Physical Structure of Protoplasm," published that year in Cowdry's comprehensive text-book of General Cytology (1924). The chief line of investigation up to that time was concerned with ascertaining the physical nature of protoplasm and its constituents, including mitochondria and nuclear inclusions. The most important features studied relate to the viscosity, the differentiation of cortex and interior, the nature of the surface film, the nature of chromatic and achromatic structures in dividing nuclei, internal and surface changes influencing cell division, protoplasmic changes accompanying fertilisation, and the effect on protoplasm of the injection of certain substances.

Since the publication of these results the main line of investigation

has been directed to a better understanding of the physiology and micro-chemistry of protoplasm by means of injection experiments. Certain important contributions have, however, also been made to the knowledge of the structure of tissues and protoplasm both of animals and plants.

As previously mentioned, studies of living cellular structures had been made principally on protozoa and marine ova. An investigation of the male germ cells of the grasshopper elucidated the structure of mitochondria and the nature of nuclear inclusions (Chambers (1924)). The cytoplasm of the germ cells is extremely sensitive to mechanical injury, and renders the determination of its consistency impossible by micro-dissection methods. It appears to be very fluid, and remains in place only when surrounded by a protoplasmic membrane. On tearing this membrane the rupture spreads rapidly and affects not only the same cell, but others in organic continuity with it. The mitochondria are the most persistent cytoplasmic inclusions; they are fixed by mechanical agitation with the dissecting needles, and remain in evidence long after the destruction of the cell. During growth of the spermatocytes the mitochondria take the form of granules or rods continually changing place, disappearing and reappearing in the cytoplasm. At nuclear division they form a striated spindle around the nuclear spindle. It is of interest to note here that a similar observation was made by Devisé (1921) in studying fixed material of *Larix*. The nuclear spindle appears homogeneous in the living cell, the substance being easily distinguishable from the cytoplasm. Fibres can be demonstrated by manipulation with a dissecting needle. The viscosity of the spindle is less than that of the chromosomes, but greater than that of the cytoplasm, and diminishes during anaphase and telophase. The resting nucleus is without visible structure with the exception of one or more included nucleoli. When a cell containing such a nucleus is wounded by the glass needle, a gelatinous reticulum is formed. This is irregular and granular in appearance, exactly resembling the reticulum of fixed material. The threads thus formed undergo no further change and are probably the result of coagulation. By dissecting cells containing nuclei in the early stages of division, the successive stages are induced to follow rapidly. Chromatic filaments and chromosomes produced artificially in this way, as well as those appearing spontaneously, are gelatinous bodies which can be stretched and torn with the needles, and which undergo swelling and contraction. The results of the manipulation of cells containing prophasic nuclei are thus in marked contrast to those obtained by treatment of interkinetic nuclei, and lead to the conclusion that to the prophase nuclei mechanical injury is a stimulant hastening the transformation of nuclear material and causing precocious development of the chromosomes.

The micro-dissection of various epithelial tissues was undertaken by Chambers and Rényi (1925) to ascertain the physical state of the living cells, whether or not they were connected, and the nature of the connection if present. The dissections were performed in most cases in Ringer's

solution or in blood serum kept at body temperature. The epithelial tissues thus operated on were the human epidermis, the corneal epithelium, intestinal epithelium, and ciliated oral epithelium of the frog, the stratified squamous epithelium from the oesophagus of the mouse, and the following tissues of the guinea-pig—transitional epithelium from the bladder, cylindrical epithelium of the renal papilla, mesothelial cells from the mesentery, pancreas and liver cells and cells of the thyroid gland.

The nucleus of all the cells studied is an optically structureless fluid body, more susceptible to mechanical injury than any other part of the cell. In spite of fundamental similarities in the behaviour of protoplasm to mechanical injury, significant differences exist in the protoplasmic consistency of the types of cells studied and the way in which the cells of the various tissues are held together, these differences being correlated with functional differences of the tissues. Organic continuity in the form of protoplasmic bridges exists between cells of stratified squamous epithelium, and is absent from all the other tissues studied.

These observations on the nucleus of the metazoan cell are in contrast with those made by Scarth (1927) on plant nuclei. He investigated the living protoplasmic structure in the cells of *Spirogyra* species, the fruit of *Symphoricarpos*, leaves of *Elodea*, and the staminal hairs of *Tradescantia*, and describes a heterogeneous appearance of the resting nucleus. "The optical character ranges from apparent homogeneity, as in *Symphoricarpos* and *Spirogyra*, through a fine grained heterogeneity in *Elodea*, to a coarsely mottled appearance in *Tradescantia*." This evidence of an elementary structure together with a fluid sap in the resting nucleus supports the view that, in plant cells at least, a persistent framework exists which might account for the genetic continuity of the chromosomes.

Scarth's observations also lead to the assumption of a structural basis of organisation of the cytoplasm. This substance consists of a matrix of certain rigidity and elasticity together with the active mobile "kinoplasm" which alone takes part in protoplasmic streaming, vacuole formation, and other cytoplasmic activities. The immobile gelatinous matrix indicates the existence of a permanent skeleton structure. If the osmotic pressure within a cell be reduced either by mechanical means or by exposure to toxic concentrations of narcotics, swelling of the cytoplasm and nucleus occurs. During such swelling the cytoplasm often lifts away from the nucleus, leaving between them a space which is apparently filled with a clear solution. The inner surface of the cytoplasmic envelope and the outer surface of the nucleus are perfectly smooth. From these observations Scarth considers the long controversy as to the nature of the nuclear membrane to be terminated, since there are two membranes, one of nuclear and one of cytoplasmic origin.

The workers at Cornell University Medical College, New York, have recently devoted themselves more especially to micro-injection methods for the study of cell physiology, one of the most important aspects of which

is the rôle of electrolytes in the maintenance of protoplasmic structure and function. Earlier methods employed in investigating this problem involved the immersion of cells and tissues in solutions of the various electrolytes, but this revealed little or nothing of their direct action on the physical state of living protoplasm, the solution of the problem remaining in abeyance till development of the micrurgical technique. *Amœba dubia* Schæffer was the material selected for the further study of cell physiology, and is especially suitable because of its rapid and characteristic reactions to the various solutions employed, is easily injected, and is not easily injured by the micro-manipulations as far as can be ascertained from its appearance and viability. In every case immersion experiments have been carried out together with the injections, and the observations point to a marked difference between the plasma membrane (plasmalemma) and the internal protoplasm.

On treating amœba with the chlorides of Na, K, Ca and Mg, Chambers and Reznikoff (1926) at once noted that the monovalent cations are decidedly more toxic to the surface membrane than are the divalent cations. In NaCl the plasmalemma becomes extremely delicate and disintegrates in certain places, allowing escape of the contents. The higher the concentration of the salt solution, the more rapid and complete is the disintegration of the membrane. Ultimately the plasmalemma entirely disappears, while part of the interior persists as an irregular coagulated mass. KCl does not bring about disintegration of the membrane, but renders it very viscous and adhesive. The toxic effect of KCl is greater than that of NaCl for any given concentration, amœbæ maintaining viability for from one to two days in Mol/104 NaCl solution, while the same strength of KCl causes death after one hour's immersion. $MgCl_2$ and $CaCl_2$ have no noticeable effect on the plasmalemma when applied externally. In these salt solutions the amœbæ remain active and appear normal.

On injection of NaCl and KCl the amœbæ draw in their pseudopodia and become quiescent. The internal protoplasm liquefies, while the suspended granules gradually sink to the lower surface of the rounded organism. When very dilute solutions or small amounts of higher concentration are used, recovery takes place by resumption of protoplasmic streaming and the extension of pseudopodia. The time required for this recovery varies from a few hours to almost a day, according to the concentration of the salt used. If recovery does not occur, all the protoplasmic granules aggregate at the lower surface of the rounded amœba, and the plasmalemma becomes extremely delicate and easily ruptured.

In contrast to this is the effect caused by injection with the chlorides of Mg and Ca. Both these salts produce to a certain extent solidification, or gelation, of the internal protoplasm, which in the case of $CaCl_2$ is accompanied by a "pinching off" of the area of the amœba affected by the injection. Solutions varying from 2 Mol to Mol/208 cause immediate solidification of the internal protoplasm. If large amounts (from half to

the entire volume of the amoeba) are injected, the entire organism immediately sets into a rigid mass with extended pseudopodia. With smaller amounts the solidification is localised to the region of the injection. With concentrations of Mol/104 and stronger, this region assumes the form of a blister which is gradually pinched off from the non-affected part of the amoeba. The rate of pinching off varies with the concentration of the CaCl_2 used. With Mol/208 the attempt at pinching off may fail and end in reincorporation of the solidified area. There is always a marked effort on the part of the amoeba to retain its nucleus if this structure is near the coagulated area and might possibly be involved in the pinching off process. With MgCl_2 solidification spreads throughout the entire body of the injected amoeba, and is accompanied by absolute cessation of protoplasmic movement with no attempts at pinching off of the first affected regions.

In comparing the effects of these four salts in these immersion and injection experiments, the different reactions of plasmalemma and internal protoplasm are very evident. K and Na are far more toxic when applied externally than when injected, the order of toxicity for the immersion experiments being K, Na, Ca, Mg. CaCl_2 is considered to have the most marked toxic effect on the internal protoplasm. This conclusion, however, must be qualified, as it is impossible to determine whether a solidified area would have recovered were it not pinched off. MgCl_2 is considerably more toxic to the interior protoplasm than either KCl or NaCl.

A comparison of the recovery from surface tears of amoebæ immersed in different concentrations of each of the above four salts shows the order of the toxicity on the reparability of the plasmalemma to be $\text{Mg} > \text{K} > \text{Na} > \text{Ca}$? The position of Ca must necessarily be questioned on account of the peculiar phenomena associated with the pinching off reaction. The salt increases the mobility of the plasmalemma and apparently facilitates repair. The greatest concentrations of the three salts in which recovery from extensive tears takes place are MgCl_2 Mol/832, KCl Mol/812, NaCl Mol/104. The order of the toxicity of these salts for the repair of surface tears is the same as that for the internal protoplasm and not that for the plasmalemma in the immersion experiments. This evidence favours the view that the reformation of the surface membrane is a function of the interior protoplasm and not solely of the pre-existing membrane, and depends upon an interaction of the internal protoplasm and the surrounding medium.

Immersion and injection with the chloride of a third monovalent cation, viz., LiCl demonstrated a disintegrating effect on the plasmalemma and a liquefying action on the interior protoplasm more marked even than that of NaCl. The opposite toxic effects of the salts of monovalent and bivalent cations were used in further experiments as criteria for a study of the antagonistic action between the chlorides of Li, Na and K and those of Ca and Mg (Reznikoff (1928)). It is evident from the immersion experiments that MgCl_2 has a markedly greater antagonism to the toxic effect of NaCl

on the plasmalemma than has CaCl_2 . The toxicity of LiCl and KCl is, however, antagonised somewhat better by CaCl_2 than by MgCl_2 . The antagonism to the toxic effects of KCl is reversed when it reacts upon the internal protoplasm, it being better antagonised by MgCl_2 in the injection experiments. HCl is found to be mutually antagonistic to NaCl in the interior of the cell, but to exert no antagonism to the salts at the exterior of the amoeba. NaOH has no antagonistic action to the salts on either the interior or the exterior of the amoeba. The injection experiments show that a dose of NaCl or KCl sufficient to liquefy the protoplasm, in combination with a concentration of CaCl_2 sufficient by itself to cause localised solidification and pinching off, will result in complete neutralisation of the specific effects of each salt.

From these experiments, therefore, it is presumed that the maintenance of the colloidal state of living protoplasm depends upon the presence of definitely proportioned amounts of different electrolytes. The relative amount of the two types of salt present must be in such proportions that the solidifying action of the one is balanced by the dispersive action of the other. The presence of Ca in the protoplast is essential for the formation and maintenance of the protoplasmic membrane.

Immersion and injection experiments on *Amoeba dubia* have also been performed with other salts of the same mono- and divalent cations, particularly solutions containing phosphate, borate, lactate, acetate, bicarbonate, carbonate and CO_2 (Reznikoff and Chambers (1927)). The predominant action on the living protoplasm is evidently that of the cation, though the anion present may somewhat modify the effect. In both types of experiment the borate is more toxic than any other salts used, and on treatment with toxic concentrations of any of the above salts of Na , the same effect is usually obtained as that produced by NaCl . An exception to this is observed on injection with NaH_2PO_4 . This treatment causes elevation of the surface membrane, "the appearance of a subjacent hyaline zone and the formation of a distinct membrane-like film or boundary around the granuloplasm within the hyaline zone." This membrane formation may be due to the action of the injected phosphate on some substance at the surface of the granuloplasm resulting in precipitation. Possibly the phosphate reacts with the Ca in the protoplasm, as it is known that the typical solidifying action of Ca is accentuated in an acid medium. As a general rule, the toxicity of the phosphates increases with increased sodium content of the salt, but in concentrated solutions NaH_2PO_4 has a more toxic effect than the di- and tri-sodium salts on account of the increased acidity. It has already been mentioned that alkalinity alone does not produce toxic effects.

Solutions containing CO_2 and carbonates of Na have a markedly solvent action on the plasmalemma both when applied internally and externally. The effect of CO_2 alone, when injected into the cell in gaseous form, is to cause liquefaction of the internal protoplasm. If the injected bubble of

CO₂ exceeds the size of the amoeba nucleus, death results with the dissolution of the plasmalemma over the entire cell, followed by scattering of the granuloplasm. The effect of the carbonates of Na on the internal protoplasm is to increase the liquefying action of the cation.

Physiologists have usually hitherto attributed the marked toxicity of CO₂ to its great penetrating power, thus implying that the toxic action is exerted on the cell interior. The injection experiments with amoeba show, however, that penetration to the interior does not cause irreversible injury unless the surface membrane is destroyed. The ability to recover normal activity depends on the preservation of an intact plasmalemma. The fact that CO₂ is more readily soluble in organic solvents than in aqueous solutions gives significance to the solvent action on the plasmalemma in that evidence is thus afforded for the lipid nature of the plasma membrane.

Lactates also exert a solvent action on the plasma membrane, that of Na being especially active when brought into contact with it from the interior by injection. The lactate is the only salt of Ca which has a destructive action on the plasmalemma. This antagonising effect of the lactate is also evident from injection experiments when the typical solidifying and pinching off effect of Ca is inhibited.

The influence of the narcotics ethyl alcohol, chloretone, ether and chloroform, is also being studied on the protoplasm of *Amoeba dubia*. Only the preliminary results of this work have at present been published (Hillier (1927)). When immersed in weak concentrations (less than 2 p.c.) of the above narcotics, the amoebæ continue their movements in an expanded condition. Lethal concentrations cause rounding up of the amoeba, sinking of its granules, and disintegration of the plasmalemma. No narcotic effects are observed on injection into the interior protoplasm. Alcohol, chloroform, and ether may produce irreversible coagula, which are then pinched off by the living portion of the amoeba.

When the narcotics are applied locally on the exterior of the amoeba, different effects are observed. With saturated chloretone solution and 95 p.c. alcohol the effects are not localised, but all the pseudopodia are withdrawn and the amoeba changes into "an actively moving limax form." Both chloroform and pure ether have a rapidly solvent action on the plasmalemma. When chloroform is allowed to diffuse against the amoeba from the tip of the micropipette, the plasmalemma is elevated, and the granuloplasm flows into the blister thus formed. These reactions resemble the initial stages in the production of a pseudopodium. On gradually withdrawing the pipette, the artificially produced pseudopodium enlarges and extends in the direction of the moving pipette. This phenomenon may possibly be of significance in connection with spontaneous pseudopodial formation.

Injection of amoebæ with aqueous and alcoholic solutions of picric acid demonstrate a non-toxicity to healthy internal protoplasm which is in contrast with a marked toxicity to the surface (Pollack (1927)). If the

internal protoplasm is injured by micro-manipulation, the picric acid causes local coagulation. This is followed by extrusion of the coagulum and resumed activity of the amoeba.

In both immersion and injection experiments the action of various soaps results in dissolution of the plasmalemma of *Amoeba proteus* (Reznikoff (1927)). The soaps used were the following sodium compounds: eleidate, laurate, linoleate, linolenate, myristate, oleate, pelargonate, ricinoleate, ricinostearolate and trihydroxystearate. The internal protoplasm does not appear to be affected. The rate at which the plasmalemma dissolves varies with the concentration of the soap used. Sodium ricinoleate displays greater toxic effect than any other soap tested.

Glycerine, dextrose and ethylene glycol all have similar effects on living amoebæ. On immersion in lethal concentrations the amoebæ become shrunken and rounded, due, apparently, to an osmotic or dehydrating effect. The injection of these substances produces an action similar to that caused by the introduction of large amounts of water, i.e. an elevation of the plasmalemma by a sudden rush of clear hyaline fluid surrounding the centrally aggregated granuloplasm. In lethal concentrations the plasmalemma is broken. This rupture may be a mechanical one or chemical action of the injected substance. Ethylene glycol is the least toxic of these three injected substances, and can be injected in small amounts of 17.7 Mol concentration without toxic effects.

The importance of many metals in certain physiological and pathological problems led to their further study by micrurgical methods. Consequently the effect of salts of certain heavy metals on protoplasm has been studied by injecting *Amoeba proteus* with the chlorides of lead, mercury, copper, iron and aluminium (Reznikoff (1926)). All these salts undergo gradual hydrolysis in solution, with increase in acidity. In the immersion experiments the death of the amoeba coincides with this production of acid, and is probably due to this increase in acidity as well as to the action of the metal cation.

The effects of injection of PbCl_2 differ from those of the other salts used. With concentrations of PbCl_2 ranging from Mol/1000 to Mol/20,000, there appears in the protoplasm an irregular glassy mass containing a few granules. Active protoplasmic movements proceed in the rest of the cell, and the glassy mass is extruded. If a second injection is made immediately after the first, no solidification occurs, but if the second injection is made after an interval of twenty minutes or more, a second solidified glassy mass may occur and be in turn extruded. These results suggest a reaction between PbCl_2 and protoplasm in which some protoplasmic constituent is used up which only gradually reforms in the cell. The solidified areas produced in the cytoplasm by the chlorides of Cu, Hg, Fe and Al, have not the peculiar glassy appearance of the coagulum formed by the PbCl_2 ; their coagulating action is also more rapid. This difference in the rate of formation and the appearance of the coagulum indicates a different

type of reaction between protoplasm and lead from that between protoplasm and the other ions studied.

The toxic effect of these salts on amoebæ immersed in them is markedly greater than their effect on injection, and indicates that the lethal action of these substances is on the plasmalemma. The plasmalemma is known to be far more susceptible to injury from acids than the interior protoplasm. This supports the view that the toxic effects of immersion are due to acidity of the salt plus the presence of the metal cation, whereas, when injected, the action of the salt is due to the cation alone.

The determination of the hydrogen-ion concentration of protoplasm is another important line of work which has been considerably developed in recent years by micrurgical technique. This problem had hitherto been studied by immersion experiments or by the use of fluid extracts from crushed tissues, both of which methods are open to criticism and can hardly be considered to give reliable results on solely intraprotoplasmic pH. It is essential to maintain the normal condition of the protoplasm during determination of its hydrogen-ion concentration, and any methods which submit the cells to abnormal conditions may seriously affect the results obtained. (The essential presence of an intact plasma membrane for the maintenance of protoplasm is realised by a consideration of the results of micro-dissection experiments.) The differences found between the results obtained with vital staining or with extracts from crushed cells and those obtained by micro-injection methods are fully considered by the Needhams (1926).

With the micrurgical apparatus both colorimetric and potentiometric methods are possible for the determination of the pH of protoplasm, the latter being carried out by the use of micro-electrodes. At present the colorimetric method alone has met with considerable success.

The indicator dyes which have proved to be most serviceable in these injection experiments are Clark and Lubs' series of pH indicators covering the range from 4.4 to 8.4 and the basic dyes neutral red and methyl red. These are prepared in aqueous solutions of sodium salts, and, in accordance with the behaviour of other sodium salts previously considered, maintain the fluidity of the cytoplasm and readily permeate it on injection. The living protoplasm can only receive a limited amount of injected dye. If too much is introduced, disintegration of the protoplasm becomes visible, the dye simultaneously registering the production of an acid. The final colour of the protoplasm remains constant as long as the cell is alive. The dyes used are, with the exception of brom thymol blue, relatively non-toxic to the cytoplasm. Brom cresol purple has displayed evidence of toxicity when injected into the nucleus.

By means of this technique it is found that the living protoplasm of widely differing types of cells has, under normal conditions, a remarkably constant pH value. This intraprotoplasmic pH has been determined for the following tissues of *Necturus* and the frog by Chambers, Pollack and

Hillier (1927):—cells of ciliated epithelium, gastric and intestinal mucosa, liver, pancreas, striated muscle and unripe ova. In every type of cell the pH values recorded are the same, viz., 6.9 ± 0.1 for normal cytoplasm, 5.3 ± 0.2 for injured and cytolysing cytoplasm, 7.5 ± 0.1 for the nucleus both normal and injured. Results in close agreement with these are obtained from the pH determination of the nucleus and cytoplasm of the starfish egg (Chambers and Pollack (1927)), viz., 6.7 ± 0.1 for normal cytoplasm of eggs in the unfertilised, fertilised and first and second cleavage stages, 5.5 ± 0.1 for injured cytoplasm, 7.5 ± 0.1 for normal and injured nucleus. In connection with these experiments on the starfish nucleus, the non-toxicity of phenol red and neutral red are well demonstrated by the fact that maturation of the germinal vesicle was observed after injections with these two dyes. The pH of *Amœba dubia* and *A. proteus* cytoplasm is also ascertained to be about 6.9 ± 0.1 . A pH value of 7.6 had previously been given by the Needhams (1925) for *A. proteus*. Using activity of the amœbæ as a criterion for toxicity of the dye (phenol red), the value 6.9 is more probably correct, as in this experiment the amœbæ are alive and maintaining the characteristic colour of the dye after 48 hours injection, while in the latter experiments death occurs within five to six minutes. The higher figure may, however, be due to conditions of culture.

Other marine ova, including those of four echinoderms, one tunicate and one polychaete worm, reveal an internal pH of about 6.6 in the normal condition (J. and D. M. Needham (1926)). This prevails in unfertilised and fertilised eggs up to the 16-cell stage. On cytolysis the pH value is lowered to between 4.0 and 5.0 (*Paracentrotus lividus*), which is considerably lower than the figure obtained for injured cytoplasm of starfish ova.

Embryos of starfish, sand dollar and sea urchin were injected and immersed in indicator dyes by Chambers and Pollack (1927) to determine the hydrogen-ion concentration of the blastocœlic fluid. In every case the fluid of normally developing embryos has the same pH as the enviroing sea water, i.e. about 8.4. This is true of every embryonic stage from the first appearance of the blastocœle until metamorphosis. If the pH of the internal medium is changed by acidifying the sea water to a value still promoting viability of the embryo, the blastocœlic fluid rapidly assumes the new pH of its surroundings. If returned to normal sea water, the indicator quickly changes to the colour characteristic for pH 8.4. These results indicate that the wall of the blastocœle of a normal embryo is freely permeable.

The production of acid is an invariable characteristic of injury to any organism thus experimented on for pH determination. This fact alone reveals the unreliability of data obtained from experiments on broken or crushed tissues. Interesting effects of different degrees of injury are recorded by Chambers and Pollack (1927) for the starfish eggs. A rapid tear in the cytoplasm causes visible disintegration. The cytolysis induced spreads away from the place of injury, but frequently the spreading may

be stopped by the formation of a membrane between the cytolysing and healthy protoplasm. A similar plasmalemma is formed around a cytolysed area if too large a puncture is made in performing an injection. The rate of this membrane formation varies according to the medium in which the eggs are immersed, and is extremely rapid if normal sea water pH 8.4 constitutes the environment. If sea water is acidified to pH 6.0 and the eggs submitted to similar treatment in this medium, the dye frequently permeates the cytoplasm. This may be due to delay in membrane formation or alteration of its permeability in an acid medium.

Colour changes observed in cytolysed areas indicate a rapid production of acid due to injury. When injected with brom cresol purple, the change from blue to yellow in the injured area of the egg indicates a lowering of the pH to 5.6 or less. On injection with methyl red a normal uninjured egg is coloured yellow. On injury, no colour change results. The pH value of cytolysed cytoplasm is thus determined to lie between 5.4 and 5.6. The acid produced by mechanical injury can also be detected in the surrounding medium if the sea water is previously coloured with suitable indicator. If coloured blue by brom cresol purple, the sea water immediately surrounding an injured egg turns yellow even before cytolysis is apparent within the egg. After a few seconds the original blue colour is restored.

Injury which cannot be detected by any visible morphological changes can, however, be recognised by this characteristic production of acid. Experiments have been performed which show that acid due to injury is produced when a normal injection is made with a micropipette or when an egg is slowly torn. In using brom cresol purple, a yellow colour is produced for about one second at the point of injury and is then replaced by the blue. This production of yellow colour is the only evidence that the cytoplasm has ever been torn.

These different reactions depending on the degree of injury are probably due to the amount of acid produced. With a very slight or slowly made tear the amount of acid produced at any given moment is small, and is probably neutralised as fast as it is formed. If an egg is vigorously torn, a large amount of acid is produced which cannot all be acted upon by the buffers in the cytoplasm, and cytolysis therefore sets in. As the tear spreads, so more acid accumulates accompanied by further cytolysis.

Injury to the germinal vesicle causes the following morphological changes: the nucleolus disappears; cytolysis sets in around the nucleus; a spherical optically homogeneous nuclear remnant persists in this dis-integrated region.

In contrast to the immediate change in pH value given by injured cytoplasm is the stability of the pH of the nucleus. Injury to the nucleus causes no increase in acidity and no increase in alkalinity. The pH value for both normal and injured nuclei is 7.5 ± 0.1 .

The micro-injection technique has also rendered possible the study of the oxidation-reduction potential of protoplasm. The investigation of

this important factor of cellular activity is due to J. and D. M. Needham (1925, 1926) of Cambridge. The results of the early work on determining the reducing powers of certain cells have, unfortunately, little value. It was not till 1928 that the possibility of the colorimetric method by micro-injection was realised. This was due to the preparation by Clark and his collaborators of dyes, which, at a constant hydrogen-ion concentration, change colour according to the oxidation-reduction potential. These dyes are mainly the indophenols and indigotines (Clark and Lubs (1917) and Clark (1922) and (1928)). Clark chose the symbol rH as a measure of reduction intensity. As pH refers to the intensity of acidity as distinguished from the total amount of acid present, so rH refers to intensity of reduction as distinguished from the total amount of reductant present. The value of rH is only of significance when the value of pH is constant for any set of comparisons.

The methods and somewhat complicated problems of technique are dealt with by the Needhams (1925) in their paper on the pH and rH of *Amoeba proteus*. Two sets of experiments were performed—(a) injection of amoeba with completely oxidised dye; (b) injection with completely reduced dye. In outline the method of procedure for injection was as follows with the completely oxidised dye:—

The dye used was a 1 p.c. sodium 1, naphthol 2, sulphonate indephenol in phosphate buffer solution at pH 7.6. The fully oxidised dye was of claret red colour. This was titrated against a titanium buffer solution till a faint dirty brown colour marked the end point of complete reduction. "Having then ascertained how many c.c. of titanium solution were required to bring the dye to complete reduction, it was only necessary to add various fractions of this figure to other samples of dye in order to get colour standards of any desired percentage reduction." The effect on the amoeba is illustrated by the following description of a typical injection experiment: "The dye penetrated the whole of the protoplasm, leaving at first a small zone of uncoloured material, rather wider than the ectoplasm, but sharply defined, all round the outer part of the cell. This uncoloured zone only persisted for a few seconds, and thereafter the entire cell was coloured. No liquefaction of the protoplasm appeared to take place, and pseudopodial movements were seen on several occasions, though more often the cell retracted such pseudopodia as it had out and settled down into a more or less spherical shape. There were never any attempts at extrusion of a blister of coloured cytoplasm. . . . Cytolysis might take place at any time, but often the cells remain uninjured for 10–20 minutes." With regard to the colour changes: "Immediately after injection the cell was deep red; within the first 60 seconds this colour rapidly faded to a very pale but quite distinct pink. That this change was not caused by diffusion into the hanging drop was clear from the fact that no trace of colour appeared outside the periphery of the cell. After it had attained to this faint pink, the fading went no further for some time. In no case did the dye in our

experiments ever go quite colourless in the cell, except immediately before cytolysis. Frequently, for 3 or 4 minutes or longer, the faint pink would be maintained, with no alteration, and appeared to be unaffected by streaming movements when these took place; later we sometimes observed further very slow fading."

By use of the colour standards it was found that the position of equilibrium at the standard pink corresponded to a reduction of from 15 to 80 p.c. It is calculated that at a pH of 7.6 the rH value of the cell interior of *Amœba proteus* lies between 17–19. The egg cells of certain marine organisms are calculated by similar methods to have an rH value between 19–22. This intensity factor therefore differs in different cells, the amoeba having a distinctly higher intensity of reduction than the egg cell. The oxidation-reduction intensity of certain anærobic protozoa has been determined to lie between rH 9.5–10.5, being thus markedly greater than that of ærobic protozoa such as amoeba. The rH of amoeba has, however, been found to remain at the same level under both ærobic and anærobic conditions, and is probably widely independent of the concentration of oxygen in the external atmosphere.

The foregoing account is an attempt to assemble the more important results of recent experiments by micro-dissection and injection on the varied phases of cellular activity. In order to obtain an adequate understanding of the processes of life, the morphological and physiological problems of living protoplasm must be attacked. Ways of approach to such knowledge of the living cell not previously possible are now opened up by the methods of the micrurgical technique.

REFERENCES.

- CHAMBERS, ROBERT (1924).—"Etudes de Micro-dissection. IV. Les structures mitochondriales et nucléaires dans les cellules germinales mâles chez la sauterelle." *La Cellule*, **35**, 107–24.
- CHAMBERS, ROBERT, and POLLACK, HERBERT (1927).—"Micrurgical Studies in Cell Physiology. IV. Colorimetric Determination of the Nuclear and Cytoplasmic pH in the Starfish Egg." *J. Gen. Physiol.*, **10**, 739–55.
- (1927).—"The pH of the Blastocœle of Echinoderm Eggs." *Biol. Bulletin*, **53**, 233–38.
- CHAMBERS, R., POLLACK, H., and HILLIER, S. (1927).—"The Protoplasmic pH of Living Cells." *Proc. Soc. Exp. Biol. Med.*, **24**, 760–1.
- CHAMBERS, ROBERT, and RÉNYI, GEORGE S. (1925).—"The Structure of the Cells in Tissues as Revealed by Micro-dissection." *Amer. J. Anat.*, **35**, 385–402.
- CHAMBERS, ROBERT, and REZNICKOFF, PAUL (1925).—"The Reaction of the Protoplasm of the Living Amoeba to Injected Salts." *Proc. Soc. Exp. Biol. Med.*, **22**, 320–22.
- (1926).—"Micrurgical Studies in Cell Physiology. I. The Action of the Chlorides of Na, K, Ca and Mg on the Protoplasm of *Amœba proteus*." *J. Gen. Physiol.*, **8**, 369–401.
- CLARK (1922).—*J. Washington Acad. of Science*.
- (1923).—Reprint No. 823 U.S. Pub. Health Reports.
- CLARK and COHEN.—Reprint Nos. 826 and 834.
- CLARK, COHEN and GIBBS.—Reprint Nos. 904 and 915.

- CLARK, COHEN and SULLIVAN.—Reprint No. 848.
- CLARK and LUBS (1917).—*J. Bacteriol.* 2, 1, 109, 191.
- COWDREY, E. V. (1924).—"General Cytology." Univ. Chicago Press.
- DEVISÉ, R. (1921).—"La figure achromatique et la Plaque cellulaire dans les Microsporocytes du *Larix europea*." *La Cellule*, 32, 253.
- HILLIER, STANISLAW (1927).—"Action of Narcotics on the *Amœba* by Means of Micro-injection and Immersion." *Proc. Soc. Exp. Biol. Med.*, 24, 427-8.
- NEEDEHAM, J. and D. M. (1925).—"The Hydrogen-Ion Concentration and the Oxidation-Reduction Potential of the Cell Interior: a Micro-Injection Study." *Proc. Roy. Soc. Lond.*, 98B, 259-86.
- (1926).—"The Hydrogen-Ion Concentration and Oxidation-Reduction Potential of the Cell Interior Before and After Fertilisation and Cleavage: a Micro-Injection Study on Marine Eggs." *Proc. Roy. Soc. Lond.*, 99B, 173-99.
- (1926).—"Further Micro-Injection Studies on the Oxidation-Reduction Potential of the Cell Interior." *Proc. Roy. Soc. Lond.*, 99B, 383-97.
- POLLACK, HERBERT (1927).—"Action of Picric Acid on Living Protoplasm." *Proc. Soc. Exp. Biol. Med.*, 25, 145-6.
- REZNIKOFF, PAUL (1926).—"The Action of the Chlorides of Lead, Mercury, Copper, Iron and Aluminium on the Protoplasm of *Amœba dubia*." *J. Gen. Physiol.*, 10, 9-21.
- (1927).—"Microsurgical Studies of Soaps, Glycerine, Dextrose and Ethylene Glycol on *Amœba Proteus*." *Proc. Soc. Exp. Biol. Med.*, 24, 380-1.
- (1928).—"Microsurgical Studies in Cell Physiology. V. The Antagonism of Cations in Their Actions on the Protoplasm of *Amœba dubia*." *J. Gen. Physiol.*, 11, 221-32.
- REZNIKOFF, PAUL, and CHAMBERS, ROBERT (1927).—"Microsurgical Studies in Cell Physiology. III. The Action of CO₂ and Some Salts of Na, Ca, and K on the Protoplasm of *Amœba dubia*." *J. Gen. Physiol.*, 10, 731-8.
- SCARTH, G. W. (1927).—"The Structural Organisation of Plant Protoplasm in the Light of Microsurgery." *Protoplasma*, 2, 189-205.
- SEIFRIZ, WILLIAM (1926).—"Elasticity as an Indication of Protoplasmic Structure." *Amer. Nat.*, 60, 124-32.

ABSTRACTS AND REVIEWS.

ZOOLOGY.

(Under the direction of G. M. FINDLAY, M.D.)

STAINING AND IMPREGNATION METHODS.

Giemsa Staining.—J. G. LACORTE ("Influence du pH dans les colorations par la méthode de Giemsa," *C. rend. Soc. de Biol.*, 1928, 98, 1579–80). The optimum pH for Giemsa staining of trypanosomes is 7·4; with solutions on the acid side the colour is too red, on the basic side too blue. G. M. F.

A Rapid Method of Staining with Iron Hæmatoxylin.—E. GALLIANO FERNÁNDEZ ("Un método rápido de coloración con hematoxilina férrica," *Bol. de la real Soc. españ. de Hist. nat.* 1928, 28, 213–16). The section is first mordanted in a 3 p.c. watery solution of iron alum for 15 minutes, washed rapidly in distilled water, and stained in a solution of acetic hæmatoxylin (hæmatoxylin 1 p.c. aqueous solution—1 c.c.; pure acetic acid—1 c.c.; distilled water—3 c.c.) until the nuclei are stained uniformly. The section is then washed for 15 minutes in tap water and in 70 p.c. alcohol for one minute. Differentiation is carried out in acetic eosin (alcoholic solution of eosin 2 p.c.—3 c.c.; pure acetic acid—1·2 c.c.). The section is then washed with ammoniacal alcohol (90 p.c. alcohol—100 c.c.; ammonia 0·1 c.c.) dehydrated, cleared and mounted in balsam. G. M. F.

The Spectrophotometric Evaluation of Mixtures of Methylene Blue and Trimethyl Thionin.—W. C. HOLMES (*Stain Technol.*, 1928, 3, 45–48). Spectrophotometric analysis affords the most convenient means for determining the proportion of methylene blue and trimethyl thionin (azure B) present in a mixture of these two dyes. The method depends upon the determination of an "absorption ratio." A suitable ratio for the purpose is that of the extinction coefficient at 640 m.u. to that at 670 m.u. On account of the difference in absorption maxima of the two dyes this ratio increases as the percentage of methylene blue decreases. The ratio value for 11 different mixtures is given.

G. M. F.

The Effect of Preliminary Treatment (Fixing Fluids) on Staining Properties of the Tissues.—A. V. TOLSTOOVHOV (*Stain Technol.*, 1928, 3, 49–56). Applying mixtures of basic and acid dye on tissues (methylene blue, eosin Y) at different pH values it is possible to find differences in the isoelectric points of the nuclei and cytoplasm of different tissues. For example, the nucleus of polymorphonuclear cells of the blood consists of the most acid protein with an isoelectric point about pH 2·5, while the nucleus of lymphatic tissues has an isoelectric point of about pH 4·0 and that of connective tissue about pH 3·4.

With this knowledge, a constant method of staining at various pH values was used to study the effect of different fixing fluids on the staining properties of the tissues. Formalin, for instance, forms inert compounds with amino groups of the protein amino acids and thus makes the tissue proteins more acid. The bivalent heavy metals, such as mercury, combine with carboxyl of amino acids and thus move the isoelectric point of the proteins towards a higher pH.

G. M. F.

Stain Substitutes.—H. J. CONN (*Stain Technol.*, 1928, 3, 41–4). Gentian violet is a mixture of quite unknown composition. Crystal violet is the best substitute, or, if a redder shade is desired, one of the methyl violets. Phloxine gives the same result as magdala red, which is a very expensive dye. G. M. F.

Further Studies on a Modification of the Gram Stain.—N. KOPELOFF and P. COHEN (*Stain Technol.*, 1928, 3, 64–9). Acetone is too strong a decolouriser for gram positive organisms and alcohol too weak for gram negative ones. Equal parts of acetone (100 p.c. c.p.) and ethyl alcohol (95 p.c.) are recommended as a decolourising agent. The time of application should not exceed ten seconds. Aqueous basic fuchsin (0.1 p.c.) should be applied as a counterstain for 20 seconds only; longer application renders gram positive organisms doubtful or gram negative.

G. M. F.

GENERAL CYTOLOGY.

Mitochondria in the Submaxillary Gland.—R. HONDA ("The General Functional Significance of the Mitochondria in the Submaxillary Gland of the Adult Albino Rat," *Anat. Rec.*, 1927, 34, 301–12, 2 pls.). In neutral or alkaline media the demonstration of mitochondria by acid-fuchsin methods is very difficult or impossible because the acid-fuchsin stain is ineffective. For success with acid fuchsin a slightly acid condition must be produced. Mitochondria are still preserved in the submaxillary gland after subjecting the cells to a temperature of 58 °C. for twenty-four hours. Mitochondria are traceable through the nuclear membrane—a relation which seems to agree with the theory of the nuclear membrane as an accumulation of chromatic bodies. At the distal end of the cell mitochondria are found to change in their staining reactions and morphology, which suggests that they are undergoing chemical modification. The serozymogen cell in the submaxillary gland is not present in all animals.

G. M. F.

Mitochondria-Cytoplasmic Ratio in Renal Tubules.—E. V. COWDRY. ("Quantitative Cytological Studies on the Renal Tubules. II. Mitochondria-cytoplasmic Ratio," *Anat. Rec.*, 1927, 36, 349–55, 1 text-fig.). The ratio of mitochondrial surface to cytoplasmic volume varies in the different segments of the tubule, being greatest in the proximal convoluted tubule, practically identical in the distal convoluted tubule and ascending limb of Henle's loop and least in the descending limb of Henle's loop.

G. M. F.

Cellular Dimensions.—P. LECOMTE DU NOUY and E. V. COWDRY ("Cytological Measurements to Test du Nouy's Thermodynamic Hypothesis of Cell Size," *Anat. Rec.*, 1927, 34, 313–28, 7 text-figs.). It has not been possible to check experimentally du Nouy's thermodynamic hypothesis of cell size in the case of fixed tissue cells. New and roughly quantitative data are, however, given regarding the volume and surface area of the principal visible cellular components. These data point to a higher concentration of proteins in the cytoplasm than in the serum and, or, to a greater surface of adsorption than is revealed by the microscope.

G. M. F.

Golgi Apparatus in Spinal Ganglion Cells.—W. P. COVELL ("A Quantitative Study of the Golgi Apparatus in Spinal Ganglion Cells," *Anat. Rec.*, 1927, 35, 149–59, 1 pl.). The Golgi apparatus may be studied quantitatively in successful preparations of spinal ganglion cells. The computed surface area of the Golgi apparatus is about one-half as large as the total cell surface. There is relatively a greater surface area of Golgi apparatus in small cells in relation to cytoplasmic volume than in large cells. In small cells there is relatively less Golgi apparatus surface in relation to nuclear surface than in large cells. There is relatively more volume to the Golgi apparatus of small cells in relation to cell and cytoplasmic volumes than in large cells. G. M. F.

Cytological Studies on Renal Tubules.—W. P. COVELL ("Quantitative Cytological Studies on the Renal Tubules. I.—Nucleocytoplasmic Ratio," *Anat. Rec.*, 1927, 35, 61–73, 1 text-fig.). The nucleocytoplasmic ratio varies for different portions of the renal tubule. In the proximal convoluted tubule of a mature rat it is roughly 1 : 9·5 ; in the distal convoluted tubule 1 : 8·3 ; in the ascending limb of the loop of Henle 1 : 6·0 ; and in the descending limb 1 : 4·6. G. M. F.

Tissue Culture.—R. G. HARRISON ("On the Status and Significance of Tissue Culture," *Archiv. f. exp. Zellforsch.*, 1928, 6, 28–42). The originator of tissue culture here summarises the contributions to biological science made through the application of this method, namely:—(i) A direct ocular demonstration of the embryological basis of the neurone concept ; (ii) a crucial proof of the myogenic theory of the heart beat ; (iii) a demonstration of the potential immortality and indefinite power of reproduction of somatic cells ; (iv) the discovery that dissociated somatic cells of animals having at least the degree of organisation found in sponges and coelenterates can reconstitute themselves into normal viable individuals by a process resembling ontogeny ; (v) a means for the exact study of growth in pure lines of cells, conditions influencing the process and the chemical nature of the medium required ; (vi) the discovery of numerous facts with regard to cell transformations that go a long way towards the solution of the vexed question of the genetic relations of blood and connective tissue elements in favour of the monogenetic or unitarian theory ; (vii) evidence regarding cell movement, the behaviour of mitochondria, the mode of connection between tissue elements and their differentiation and de-differentiation ; (viii) the opening of the process of cell division to direct observation ; (ix) the discovery that tumour cells have the power of indefinite multiplication outside the body without losing their properties ; (x) the direct observation of the behaviour of tissue cells towards micro-organisms and the conditions under which certain immune reactions occur ; (xi) the opening of tissue cells to the direct action of drugs whereby the influence of the latter on living protoplasm may be studied. G. M. F.

Modern Techniques of Tissue Culture and Results.—A. CARREL (*Arch. f. exper. Zellforsch.*, 1928, 6, 70–81). A description of the technique and the results obtained with pure strains of cells and the substances necessary for their continuous growth. G. M. F.

Tissue Culture and Bacteriological Problems.—C. LEVADITI ("L'importance des cultures cellulaires du point de vue bactériologique, immunologique et chimiothérapeutique," *Arch. f. exper. Zellforsch.*, 1928, 6, 187–206). The questions discussed are the mechanism of action of toxins, toxalbumins and venoms, active and passive immunity, cultivation of ultramicroscopic viruses and chemiotherapy. G. M. F.

Polyhedral Viruses.—R. W. GLASER and E. V. COWDRY ("Experiments on the Visibility of the Polyhedral Viruses," *J. Exp. Med.*, 1928, 47, 829-34). No quantitative differences were found between the particles visible in normal blood and in blood from cases of wilt disease and grasserie, even with the use of the most refined optical methods. From this it is believed that the viruses of wilt disease and grasserie are almost certainly invisible with our present optical equipment.
G. M. F.

Micro-injection of *Amoeba proteus*.—PAUL REZNIKOFF ("Micrurgical Studies of Soaps, Glycerine, Dextrose and Ethylene Glycol on *Amoeba proteus*," *Proc. Soc. Experimental Biol. and Medicine*, 1927, 24, 380-82). Immersion and injection experiments on *Amoeba proteus* were performed with various soaps, glycerine, dextrose and ethylene glycol. In both types of experiment the action of the various soaps results in dissolution of the plasmalemma, with apparently no effect on the internal protoplasm. The rate of solvent action of the soap varies with its concentration. On immersion in lethal concentrations of glycerine, dextrose, or ethyl glycol, the amoebæ shrink and become rounded, due to a dehydrating effect. Injection with these substances results in a lifting of the plasma membrane by the "rushing" action of the underlying hyaline fluid. Injection with lethal concentrations causes rupturing of the membrane. Ethylene glycol is the least toxic of these three injected substances.
J. L.

pH of Echinoderm Embryos.—ROBERT CHAMBERS and HERBERT POLLACK ("The pH of the Blastocoele of Echinoderm Embryos," *Biol. Bull.*, 1927, 53, 233-38). Embryos of *Asterias forbesii*, *Echinarachnius parma*, and *Arbacia punctulata* were injected with indicator dyes and immersed in sea-water coloured with indicator dyes to determine the pH of the blastocoele fluid. Clark and Lubs' indicators were used, prepared in aqueous solutions of NaOH. In every case the colour of the dye shows that the fluid of normally developing embryos has the same pH value as the surrounding sea-water, i.e. about 8.4. This is true of every embryonic stage from the first appearance of the blastocoele until metamorphosis. If the sea-water is made acid or alkaline, the dye within the blastocoele always changes within a few seconds to the colour typical for the pH of the surrounding medium. These facts indicate that the wall of the blastocoele of a normal embryo is freely permeable. An acid reaction is invariably produced by injury to the cells.
J. L.

Action of Certain Salts on Living Protoplasm.—PAUL REZNIKOFF and ROBERT CHAMBERS ("Micrurgical Studies in Cell Physiology. III. The Action of CO₂ and Some Salts of Na, Ca, and K on the Protoplasm of *Amoeba dubia*," *Journ. Gen. Physiol.*, 1927, 10, 731-38). Immersion and injection experiments were performed on the cytoplasm of *Amoeba dubia* with the following salts of Na, Ca, and K, viz., phosphate, borate, lactate, acetate, bicarbonate and carbonate. The predominant action on living protoplasm is evidently that of the cation, though the effect may be modified by the anion present. In immersion experiments toxic concentrations of the sodium salts produce rounding of the amoeba, quiescence of its contents, and sinking of the heavier granules; on injection with these sodium salts, the fluidity of the cytoplasm is increased. A different reaction follows injection with NaH₂PO₄, viz., elevation of the surface membrane and formation of a second membrane around the central granuloplasm. Usually the toxicity of the phosphates increases with increased Na content, but in concentrated solutions, NaH₂PO₄ has the most toxic effect on account of the increase in acidity. The borates are more toxic than any other salt used in both types of experiment.

The carbonate and bicarbonate of Na come next to the borate in toxicity because of their marked solvent action on the plasmalemma. CO₂ injected in gaseous form produces liquefaction of the internal protoplasm. If a bubble exceeding the size of the amoeba nucleus is injected, death results with dissolution of the plasmalemma. Lactates also have a solvent action on the plasma membrane. The lactate is the only salt of Ca which has a destructive action on the surface, this being due to the antagonising effect of lactate on the typical solidifying action of Ca. The results obtained from these experiments emphasise the importance of an intact plasmalemma for the maintenance of the life of the cell. J. L.

pH of Nucleus and Cytoplasm of Starfish Eggs.—ROBERT CHAMBERS and HERBERT POLLACK ("Micrurgical Studies in Cell Physiology. IV. Colorimetric Determination of the Nuclear and Cytoplasmic pH in the Starfish Egg," *Journ. Gen. Physiol.*, 1927, 10, 739-55). An account is given of the methods and material used in the micro-injection experiments of the eggs of *Asterias forbesii* for pH determination. The following pH values are given:— 6.7 ± 0.1 for normal cytoplasm of eggs in the unfertilised, fertilised and first and second cleavage stages; 5.5 ± 0.1 for injured cytoplasm; 7.5 ± 0.1 for normal and injured nuclei. The non-toxicity of the dyes used (phenol red and neutral red) is shown by the fact that maturation of the nucleus was observed to follow injections with these two dyes. Injury to the cytoplasm invariably results in the production of acid. The lowering of the pH value may or may not be accompanied by visible disintegration depending on the degree of injury inflicted. Injury to the nucleus causes no increase in acidity nor in alkalinity even when accompanied by distinct morphological changes. The rate of formation of a plasmalemma around a cytolysed area is apparently influenced by the acidity of the surrounding medium. J. L.

Antagonistic Actions of Cations on Living Protoplasm.—PAUL REZNIKOFF ("Micrurgical Studies in Cell Physiology. V.—The Antagonism of Cations in Their Actions on the Protoplasm of *Amoeba dubia*," *Journ. Gen. Physiol.*, 1928, 11, 221-32). Micro-injection and immersion experiments performed on *Amoeba dubia* with the chlorides of Li, Na, K, Ca and Mg show that the salts of the monovalent cations disperse the plasmalemma and increase the fluidity of the internal protoplasm, while the salts of the bivalent cations have no dispersive action on the plasmalemma and tend to solidify the internal protoplasm. The opposite actions of the salts of mono and bivalent cations are therefore used as criteria for studying antagonism between the chlorides of Li, Na and K and those of Ca and Mg. In immersion experiments MgCl₂ is more antagonistic to the toxic effect of NaCl on the plasmalemma than is CaCl₂. CaCl₂ is, however, more antagonistic to LiCl and KCl than is MgCl₂. In injection experiments the antagonism to the toxic effect of KCl on the internal protoplasm is reversed, the toxicity being better antagonised by MgCl₂ than by CaCl₂. J. L.

VERTEBRATA.

Histology.

Otoliths from Fishes in Spain.—J. S. ECHEVERRIA ("Investigaciones sobre otolitos de peces de España," *Bol. de la real Soc. españ. de Hist. nat.*, 1928, 28, 159-66, 2 pls.). In all genera of the family Clupeidae there is a general form which, with small individual variations, is constant for each species. *C. pilchardus* and *C. alosa* are very similar, as are *C. aurita* and *Engraulis encrasicolus*. *C. spratus* is unique. G. M. F.

The Action of Radiations on the Leucocytes.—A. LACASSAGNE and G. GRICOUROFF ("De l'action des radiations sur les leucocytes du sang, étudiée au moyen de la méthode des cultures," *Arch. f. exper. Zellforsch.*, 1928, 6, 303-15). The polymorphonuclear leucocytes in tissue culture are relatively insensitive to radiations, as are monocytes. Lymphocytes are slightly more sensitive, but the leucopenia following X-ray exposure of the entire animal must be regarded as due to lesions produced in the leucoblastic tissues. G. M. F.

Embryology, Evolution, Heredity, etc.

Definitive Ova in the Rat.—E. O. BUTCHER ("The Origin of the Definitive Ova in the White Rat (*Mus norvegicus albinus*)," *Anat. Rec.*, 1927, 37, 13). The definitive ova of the rat are thought to be derived from the germinal epithelium from six or seven days after birth until fecundity is lost in old age, and not to be derived from the germ cells which are found in the ovary at birth. The formation of the definitive ova is retarded after puberty but passes through cyclic phases of activity corresponding to the oestrous cycle. The fact that no synapsis was observed in the course of the transition of germinal epithelium cells into germ cells is supposed by the writer not to be a serious objection to the idea of the post-pubertal neoformation of germ cells. The writer considers that the presence of successive stages from the ordinary epithelial cell to the Graafian follicle provides sufficient evidence that they are true oocytes. A. S. P.

The Development of the Pig Testis.—K. T. BASCOM and H. L. OSTERUD ("Quantitative Studies of the Testis. III. A Numerical Treatment of the Development of the Pig Testis," *Anat. Rec.*, 1927, 37, 63). An attempt is made to study quantitatively the growth of the pig testis, with special reference to the pre-natal stages. Sudden increase in the growth rate of the testis is found at about 20 cm. crown rump length, but the rates of growth of mediastinum, tunica albuginea and sex cords are approximately equivalent. The growth of the interstitial tissue exceeds that of these elements after the 20 cm. stage until at least four weeks after birth. The interstitial cells themselves form about 70 per cent. of the interstitial tissue at about 12 cm., whereas at about one year after birth they form more than 90 per cent. of the tissue. No increase in the diameter of the sex cords is found between the 9 cm. stage and four weeks after birth, but the total length of the cords increases by about 100 times. A similar state of affairs is also found in sheep and cattle. It is suggested that this constancy in the diameter of the sex cords is a function of the rate of metabolism of the cells and of the rates of diffusion of the food substances and waste products. An acceleration of testis growth is found at about the time they descend to the scrotum. A. S. P.

The Chromosomes of a Snake.—KENJI NAKAMURA ("On the Chromosomes of a Snake, *Natrix tigrina*," *Memoirs Coll. Sci., Kyoto Imperial Univ.*, Ser. B, 1928, 4, 18, 2 pls., 2 text-figs.). The paper is concerned entirely with the chromosomes in spermatogenesis, no account being given of the condition in the female. The spermatogonial or diploid number of chromosomes was found to be 40. These consisted of eight pairs of larger chromosomes (five pairs of V-shaped, one pair long rod-like, two pairs of short rod-like), and 12 pairs of small chromosomes. This arrangement is typical of that found in other Sauropsida. Two homologous sex-chromosomes are present and constitute one of the two pairs of short rod-like chromosomes. These are not recognisable in the spermatogonia, but exhibit heteropycnosis in the primary spermatocytes, where they appear as two karyosomes in contact in the

leptotene stage. The author considers on these grounds that the male is homogametic, and suggests that the female will be found to be heterogametic. Previous workers on reptilian chromosomes have found the male to be the heterogametic sex.
F. W. R. B.

The Thyroid and Hypophysis in Amphibian Larva.—B. M. ALLEN ("Influence of the Hypophysis upon the Thyroid Gland in Amphibian Larvæ," *Univ. Calif. Publ. in Zoology*, 1927, 31, 53-78, 2 pls.). The technique consisted in hypophysectomy and thyroidectomy of tadpoles and of implantation into these and into normal tadpoles of fragments taken from adult frogs of pars anterior, pars posterior, or pars intermedium. The complete removal of the hypophysis and the degree of success in implantation were tested by subsequent autopsy. Hypophysectomy resulted in marked retardation in the development and metamorphosis of the tadpoles. This condition was accompanied by impairment of the growth of the thyroid as compared with those of the controls. The small size of the thyroid was due to the small quantity of colloid stored in the follicles. Implantations of fragments of the posterior or intermediate lobes into hypophysectomised tadpoles did not bring about normal metamorphosis or growth of the thyroid gland, although the grafts were functional as shown by the pigmentation. Successful implantation of anterior lobe substance into hypophysectomised tadpoles resulted in metamorphosis and thyroid growth not only equalling but actually exceeding the normal. The large size of the thyroid gland was due to the distension of the follicle with colloid. The amount of anterior lobe implanted, having been taken from the adult frog, was usually larger than that of the anterior lobe of a normal tadpole, a fact which probably accounts for the excessive reactions obtained. Implantation of the anterior lobe into thyroidectomised tadpoles, however, completely failed to induce metamorphosis. These experiments show that the process of metamorphosis in anuran larvæ is produced by the action of the anterior lobe of the hypophysis working through the thyroid gland. Both the anterior lobe and the thyroid are essential for metamorphosis. F. W. R. B.

Suprarenal Tissue and Development.—M. FERREIRA DE MIRA ("Le tissu surrénal dans l'alimentation des souris. Effets sur le développement de l'organisme et sur la fonction sexuelle," *Arch. portugaises des Sci. biol.*, 1927, 2, 84-94, 4 pls.). Feeding with suprarenal tissue produces hypertrophied development of the testicles, while motor activity and pugnacity are also increased. G. M. F.

INVERTEBRATA.

Mollusca.

"Auto-Fecundation" in *Bullinus contortus*.—E. BRUMPT ("Étude de l'autofécondation du mollusque aquatique pulmoné, *Bullinus contortus*," *Compt. rend. Soc. de Biol.*, 186, 1012, 4 text-figs.). Twenty-three *Bullinus contortus* from Corsica were isolated from birth in Borrel tubes kept at 25° C., and fed with lettuce leaves. All but one laid their first egg capsules from the 21st to the 26th day after their birth. Since dissected or sectioned animals showed ova and ripe spermatozoa in the same glandular acini, and since their eggs extruded two polar bodies, this must be a case of autofecundation, not parthenogenesis. When the animals are not more than 5 mm. long, they produce small capsules containing only four or five eggs. Their form and colour are the same as that of the eggs of non-isolated specimens, including those subsequently laid by these individuals themselves. Adults, aged about six months, lay 18 or 20 eggs at a time. The self-impregnated

eggs developed normally and hatched on the tenth day. By isolating 21 of these new-born snails Brumpt obtained a second virgin generation, which again laid eggs from the 22nd day onwards. Some of these hatched as early as the sixth day. Similar experiments are in progress on *Planorbis metidiensis*, another host of *Schistosoma hæmatobium*. Isolated specimens laid eggs a month after birth. Auto-fecundation is quite a common phenomenon amongst gasteropods; apparently neither autocopulation nor crossed copulation are necessary for the perpetuation of the race.

E. W. B.

Polyvitelliny in Pond Snails.—E. D. CRABB and R. M. CRABB (*Biological Bulletin*, 1927, 53, 318–326, 1 pl.). A certain proportion of the eggs of pond snails are found to possess more than one vitellus. The laying of such eggs does not seem to be a hereditary character. Eggs of *Physa sayi*, *Lymnæa stagnalis appressa*, *L. columella*, and *L. palustris* were used in this investigation. Formaldehyde was the preservative. All the eggs laid by a particular snail or group of snails during the period of observation were preserved. Polyvitelline eggs are not necessarily larger than normal ones. There are some cases of adherent eggs in which six normal eggs are joined together in one string; this does not seem to be connected with polyvitelliny. The early stages of these eggs are normal where less than a dozen vitelli are present. Not more than four snails have been hatched from a single egg. Twenty *L. stagnalis* produced 19,863 eggs, of which 273 were polyvitelline. The proportion was less in *L. palustris*. The vitelli produce independent embryos, not true twins; they are not mutually attached, nor abnormal.

E. W. B.

Minute American Zonitidæ.—H. B. BAKER (*Proc. Acad. N. S. Phila.*, 1928, 80, 1–44, 8 pls.). An illustrated account of the anatomy of *Guppya bioolleyi*, *gundlachi*, *Euconulus fulvus*, *chersinus*, *Habroconus cassiquiensis*, *elegantulus*, *trochulinus*, *Retinella hammonis*, *binneyana*, *Oxychilus draparnaldi*, *Glyphyalinia indentata*, *rhoadsi*, *carolinensis*, *burringtoni*, *Pseudovitrea minuscula*, *Pycnogyra berendti*, *Paravitrea capsella*, *multidentata*, *lamellidens*, *Striatura exigua*, *milius*, *ferrea*, *Zonitoides nitidus* and *arboreus*. There is a large amount of information about all of these. The author has standardised his own use of terms describing different parts of the genitalia; he has retained several of the French terms used by Moquin-Tandon. The paper is mainly descriptive, and cannot be condensed; we can therefore only note a few points of special interest to English malacologists. The Vitrininæ are quite close to the Zonitinæ, but are omitted from the present paper; they are placed in the key next to the Euconulinæ. These two groups are characterised by the possession of multicuspid marginals, probably a primitive character. The poor development of the spermatheca and the lack of highly differentiated penial appendages distinguishes the Holarctic and American forms from allied Asiatics. This last difference is not considered very important, as some form of dart apparatus (or pugio) occurs in the larger species of three of the sub-families discussed in this paper (including the Vitrininæ), and in fact may be present in some and absent in other species of the same genus (see *Striatura*). The Zonitinæ here includes the groups *Zonites* of Europe, *Mesomphix* and *Glyphyalinia* of America, and *Retinella* common to both. Ariophantiniæ are separated from the previously mentioned sub-families by their uniform sole (not tripartite); the dominance of unicuspid marginals in the radula, and the simple spermatheca. This section includes the European *V. crystallina*, with the American *Pseudovitrea minuscula*. The fourth group is Gastrodontinæ, which includes our *Z. nitidus*. "If previously published accounts of the genitalia are correct, the European

examples of this species belong in a different genus from American ones." *Z. arboreus* Say is stated to have anatomy similar to that of *Z. nitidus*. *Z. excavatus* "is another member of the group." "In conclusion of this paper, I wish to make an apology for the large number of groups which I have given generic rank. I, too, believe that this recent fad for the erection of multitudinous genera is a passing phase of systematic work, and that we will again return to a proper concept of the difference between genus and species. . . . Unfortunately . . . a return to larger genera in the present family would actually cause more confusion in the nomenclature of our common species than does the scheme proposed here." E. W. B.

Recent and Fossil Viviparidæ: a Study in Distribution, Evolution, and Palæogeography.—B. PRASHAD (*Memoirs of the Indian Museum*, 1928, 84, 153-252, 1 map, 1 pl.). An unusually important treatise, for which the author has collected information and specimens in many lands and ransacked all available sources of information. The distribution of the Viviparidæ is carefully described; their means of dispersal (more limited than in the case of most forms) are discussed; their geological record examined at considerable length; the main questions of palæogeography are described and illustrated from the forms here dealt with; the value of previous classifications is discussed, and a single new name is added to the list. The zoogeographical regions proposed by various authors for different groups of the animal kingdom are of no value for the Viviparidæ. They apparently did not descend from a single ancestral form, but had a polyphyletic origin in Western Europe, North America, Peninsular India, and Australia. Except *Cleopatra* Troschel and *Larina* A. Adams, which are only provisionally included in the family, all the species are ranged under one genus *Viviparus*, a selection of the generic names proposed later being adopted as subgenera. The British fossil Viviparids represent the earliest known forms from any area. The genus is absent from South America, North and South Africa, and the Arctic regions. The middle African forms appear to be of Indian origin. The characters of shell-banding and the chætæ of the embryonic shell differ in the four principal foci of development mentioned above. E. W. B.

The Mantle and Shell of the Viviparidæ.—B. PRASHAD (*Memoirs of the Indian Museum*, 1928, 84, 253-319, 5 pls., 2 text-figs.). A continuation of Annandale's work on the shell-sculpture of Viviparidæ. The author describes his material and methods; the photomicrographs were made in the Wetzlar works through the kindness of Dr. Leitz. An historical review is given of the various opinions which have been held on the relation of mantle and shell in gastropods; another deals similarly with the structure of the shell, while a third details the literature of the embryonic shell gland and the associated structures in molluscs. The author's own account is based upon the examination of an unusually long series of closely related species, and is well illustrated. The names "shell-gland" and "preconchylian invagination" are discarded as inappropriate. The secretion of the shell is entirely due to the mantle. The periostracum and the ostracal calcareous zone are secreted by the mantle margin, while the general epithelial covering of the mantle behind the supramarginal ridge produces the hypostracal calcareous zone. The calcium carbonate is in the form of aragonite in the thick-shelled forms, of calcite in the thin-shelled ones. The marginal processes of the mantle (here figured in a number of forms) are correlated with the spiral ridges of the sculpture. The colour bands in Vivipara are situated between the ostracum and the hypostracum, the colour being secreted with the hypostracal layers. The periostracum is entirely organic and consists of modified

scleroproteins, to which the name of conchiolin has been given. It is secreted by the cells of the supramarginal groove in the form of a solution. It gives a positive biuret reaction for some time after secretion. The calcareous material for the formation of the shell is taken in the form of carbonate with the food and passes from the alimentary canal into the liver. From the liver it is carried with the blood stream and stored in the connective tissue of the mantle, and probably also in other areas, in the form of calcosphærites. The chemical reactions of the calcosphærites show that they do not consist entirely of calcium carbonate, but also have an organic matrix. Later they undergo a change and become transformed into a double organic salt with the calcium in the form of a phosphate; at this stage they are found as shining rounded globules lying near the bases of the gland cells of the supramarginal ridge. From here they pass into the gland cells and are excreted with their mucus. The formation of the fibrillæ in the so-called prismatic layers appears to be due to the interaction of an organic albuminous substance; but here we have no certain evidence. In continuing Annandale's work Prashad has freely corrected numerous mistakes. E. W. B.

Arthropoda.

Arachnida.

A New Water-Mite.—T. UCHIDA ("Notes on a New Water-Mite from a Hot Spring," *Annotationes Zoolog. Japonenses, Tokyo*, 1927, 11, 111-14, 3 text-figs.). A new Formosan water-mite, *Eylais thermalis*, is described from a hot spring (42° C.) at Shokei, near Taihoku. The species bears some resemblance to *E. setosa* Koenike and *E. rimosa* Piersig in the shape of the eye-plate, but differs from them in the narrowness of the bridge and the deepness of the anterior incision and in the relative position of the hair papillæ and chitinous process at the middle portion of the bridge. G. M. F.

Portuguese Spiders.—AMÉLIA BAGELAR ("Aracnídeos Portugêses," *Bulletin de la Société Portugaise des Sciences Naturelles*, 1927, 10, No. 12, 129-38). The present paper is a continuation of a list of the Portuguese spiders previously published in the same journal (*Bull. Soc. Port. Sc. Nat.*, 10, No. 8, 87-97), and includes 45 species and sub-species, 13 of which are here recorded from Portugal for the first time. M. E. M.

Spermatozoa of Spiders.—E. WARREN ("The Comparative Histology of the Testis and Origin of the Spermatozoa in Certain South African Spiders," *Ann. Natal Mus.*, 1928, 6, Pt. 1, 1-88, 7 pls., 5 text-figs.). In the *Annals of the Natal Museum*, vol. 5, Pt. 3, 1926, the author gave an account of the occurrence of amitosis in the development of the embryo, and also in the germinal cells which produce the oöcytes in *Palystes natalius* Karsch. These observations disclosed the fact that amitotic division of nuclei occurred not infrequently in the tissues of the testis, and that in one and the same testis the spermatozoa could arise in various ways, their size and general aspect differing according to the mode of origin. It was further noticed that there was undoubtedly a tendency for the occurrence of a rhythm in the production of the different kinds of spermatozoa. Since the subject possessed a considerable interest in connection with the current views on the functions of chromosomes, a number of other South African spiders have been examined, and it was found that there were very remarkable difference in the chromatin behaviour in the spermatogenesis of the various species. In some species amitosis was found abundantly, while in others

it was seen only among the germinal cells and spermatogonia, and after the definitive primary spermatocytes were formed, typical karyokinesis occurred extensively, or even perhaps exclusively, in the production of the spermatids. In many of the species examined, spermatozoa of two kinds are formed, and these may differ from each other markedly in size and shape. The scope of the present paper includes an outline sketch of the comparative histology of the testis in a number of different spiders, and a preliminary account of the atypical modes of nuclear division which were found in the development of the spermatozoa, together with certain observations on the mode of formation of the spermatozoa from the spermatids (spermiogenesis). The present observations also demonstrate that sometimes there is a remarkable lack of relationship between general body size and the sizes of the spermatozoa, spermatids, spermatogonia. A full and careful account of the various units and their development is given for all the species dealt with, accompanied by excellent illustrations. At the end of the paper the author summarises the results of his work and observations under 17 conclusions which are of considerable interest.

M. E. M.

Insecta.

Indian Ichneumonidae.—R. A. CUSHMAN ("New Indian *Ichneumonidae*," *Records of Indian Museum*, 1927, 29, Pt. 4, 241-47). The insects described have been received at various times from the Forest Zoologist at Dehra Dun, United Provinces, India. The species of the following list are described: *Callipehialtes odinæ* sp. nov., *Campoplegidea deodaræ* sp. nov., *Charops ganges* sp. nov., *Hyposoter lymantriæ* sp. nov., *Diocles gardneri* sp. nov., *Diocles argenteopilosa* Cameron, *Pristomerus microdon* sp. nov., *Mesochorus facialis* Bridgman.

M. E. M.

Morphology and Bionomics of *Embia minor* sp. nov.—S. MUKERJI ("On the Morphology and Bionomics of *Embia minor* sp. nov., with Special Reference to its Spinning Organ. A Contribution to Our Knowledge of the Indian *Embioptera*," *Records of Indian Museum*, 1927, 29, Pt. 4, 253-82). The *Embioptera* or *Embiidina* is an isolated group of rare insects possessing peculiar structural modifications. The members of the group are more or less gregarious, living in a fairly long meshwork of tunnels which are generally constructed over sheltered damp spots. Although some interesting features regarding the habitat of a few Indian embiids have been recorded, very little is known about the actual feeding habits of these insects. Most of the previously published work on these insects deals with their systematic position, and our knowledge of their internal anatomy is still poor. In the present paper the author deals with the external morphology and the internal anatomy, as well as with some of the peculiar habits of a species of *Embiidina* collected in Bihar. He also records his observations on the spinning apparatus of this insect, the work being undertaken with the object of clearing up the confusion regarding the exact position of this organ. In the case of the respiratory system, the tracheal connectives, the position, the structure and the size of the spiracles of different regions of the body are dealt with in detail. The views of the earlier authors as to the position of the spinning glands are discussed, and Enderlein's statements as regards the position of the spinning glands are considered. Rimsky-Korsakow's view about the apparent absence of a contrivance for the extrusion of the fluid-contents of the metatarsal gland vesicle is also discussed. A detailed description of the size and the structure of the metatarsal gland-vesicles or the glandular reservoirs and their ducts is included, and the minute structure of the glandular reservoirs in the metatarsi is described. The controlling mechanism for the pressing out of the fluid contents of the glandular

reservoirs in the metatarsi is also described in detail. Some observations on the habitat of these insects and their feeding habits are recorded. The views of the various authors regarding the formation of the tunnels and their function are considered fully, and experimental evidence is adduced to show that they are by no means perfect protective recesses in nature.

M. E. M.

Philippine Stephanidæ.—E. A. ELLIOTT ("New *Stephanidæ* from Borneo and the Philippine Islands.—III," *Philippine Journ. Sci.*, 1927, 34, No. 4, 349-62.) The paper is concerned with the species of the sub-family *Diastephanus*. A key to 21 species is provided, and descriptions of all are given in the subsequent part of the paper. Many are new species and are here described for the first time.

M. E. M.

Philippine Muscoidæ.—C. H. TYLER-TOWNSEND ("New Muscoidæ from the Philippine Region," *Philippine Journ. Sci.*, 1927, 34, No. 4, 365-97). This paper presents some of the results of a study of material sent to the author by the late Professor Charles F. Baker. A large number of new genera and species are erected, and descriptions of these genera and species are provided.

M. E. M.

Insect Physiology.—PAUL S. WELCH ("Symposium—Needed Lines of Investigation in American Entomology: Insect Physiology," *Ann. Ento. Soc. America*, 20, No. 4, 429-36). Insect physiology, by the nature of its content, does not lend itself readily to geographical distinctions. The author's discussion, therefore, contains little that is characteristically American in its bearing. As a sub-science the physiology of insects stands at the threshold of its development, despite numerous scattered investigations in the past which have used insects as material. The author sets himself the task of indicating the investigations most urgently needed to throw light on many of the as yet but vaguely understood phenomena which confront us. Respiration in insects has held the interest of many investigators. Its fundamental rôle is the maintenance of life, the innumerable modifications of the accessory organs, the versatility of insects in utilising direct and indirect sources of oxygen supply, the intimate relation of respiration to economic problems—all these have done much to direct attention to study in this field. Discussing the "Functions of Organs," the author points out that even the functions of well-known organs are imperfectly known, and that the function of many in respiration is apparently inferential only. Several instances of this are cited. The significance of "Reduced Organs," the "Function of the Gills," "Carbon Dioxide Elimination," "Anærobic Respiration," and "Other Problems in Respiration" are considered and commented upon, the work and published records of many investigators being referred to. On the subject of "Insect Blood" the author draws attention to several interesting problems under the headings "Respiratory Pigments or Proteins" and "Physical Changes in the Hæmolymph." "Nutritional Problems" are discussed under the two headings "Influences of Associated Organisms" and "Dissolved Organic Matter," while "Body Surface Features" and "Hydrogen-ion Concentration" are also matters of importance dealt with by the author. The paper includes a list of 33 references to the literature cited.

M. E. M.

Tasmanian Lepidoptera.—A. J. TURNER ("A Revision of the *Lepidoptera* of Tasmania," *Papers and Proc. R. Soc. Tasmania*, 1927, Pt. 2, 29-65). In this continuation of the list already given in Part 1 the author makes a few corrections and additions to Part 1. The remainder of the paper takes the

form of a long list of families, genera, and species of the Tasmanian *Lepidoptera*, with records of their distribution and notes on the corrections referred to Part 1.

M. E. M.

Tasmanian Spiders.—V. V. HICKMAN ("Studies in Tasmanian Spiders," *Papers and Proc. R. Soc. Tasmania*, 1927, Pt. 2, 158-75, 2 pls., 8 text-figs.). Of the family *Aviculariidae* full descriptions are given of two new species, namely, *Anagippe tasmanica* sp. nov. and *Arbanytis nestoni* sp. nov., including field notes on these species. Under the family *Hypochilidae* the author discusses the distribution of the cave spider, *Ectatosticta troglodytes* Higg. and Pett. in Tasmania, with notes on its web and a description of the male. Of the family *Argiopidae* the web and habits of *Cyrtophora parnasia* L. Koch are described in detail for the first time.

M. E. M.

***Psocus sexpunctatus* Linn.**—J. V. PEARMAN ("The Life-History of *Psocus sexpunctatus* Linn.," *Ann. Report and Proc. Bristol Nat. Soc.*, 1927, 6, Pt. 5, 4th Series, 384-87). *Psocus sexpunctatus* is one of the commonest and at the same time one of the prettiest of European psocids. It may be readily recognised by the semicircular row of six spots in the apex of the fore-wing, to which it owes its name. *P. sexpunctatus* occurs in numbers on the trunks of nearly all fairly smooth-barked, green-coated trees in South-West England (i.e. horse-chestnut, lime, and beech). The females oviposit during August, and the author gives an interesting account of the peculiar manner in which the ova are laid; in consequence, the eggs, under a protective coating, pass through the winter and on to mid-May, when hatching begins. A description of the embryo and the metamorphic stages is given, the remainder of the paper dealing in an interesting way with the habits and general life-history of this insect.

M. E. M.

Apterygota of S.W. England.—H. WOMERSLEY ("The Apterygota of South-West England," *Ann. Report and Proc. Bristol Nat. Soc.*, 1927, 6, Pt. 5, 4th Series, 372-79, 2 text-figs.). The present paper is Part 4 of the list. In the south-western region of England five species belonging to two families and four genera have been recorded. Of these, three species are new to science. In the *Thysanura* a systematic survey of the *Machilidae* along the shores of the Bristol Channel is being made, and has already brought to light a new species of the genus *Petrobius* from the Devon and Somerset coasts. While a number of new localities for the *Collembola* are to be recorded, only four species are new in the south-western area. For the first time a few records from Lundy are available, but it is hoped in the near future to investigate thoroughly the *Apterygota* of the island. The author records and describes the habitat of a large number of species, the total number of *Collembola* for this area now being 85 species.

M. E. M.

South Indian Braconidae.—T. V. RAMAKRISHNA AYYAR ("A Contribution to Our Knowledge of South Indian Braconidae. Pt. 1. Vipioninae," *Mem. Dept. Agric. India*, 1928, 10, No. 3, 29-60, pls. 5-14, 1 coloured). The increasing interest evinced by many economic entomologists at the present time on what is known as the biological method of pest control has contributed considerably to stimulate the study of parasitic insects, and especially of the parasitic *Hymenoptera*—a group of insects which, more than any other, includes numerous forms which play their remarkable rôle as natural enemies of many injurious insects all over the world. The study of these parasitic insects has

nowadays taken an additional turn, and attention is now being directed, wherever possible, to the investigation of the bionomical aspects of these forms, particularly to their host relations and habits, which might possess some economic importance. With this latter aspect prominently in view, an attempt is made in this paper to give a systematic account of the species of the wasp family *Braconidae* so far noted from Southern India, with whatever notes and observations available on their different biological aspects. The author describes the position, distinguishing features and classification of the *Braconidae*, the economic importance of the family, the previous records from India, and lists the 14 sub-families found represented in Southern India until now. Detailed descriptions are given of 33 genera and species, many of which are new to science, and excellent illustrations of stages in the life-history of some species are included.

M. E. M.

The Structural Characters of Macrosiphum, Aphidæ.—L. B. SOLIMAN ("A Comparative Study of the Structural Characters Used in the Classification of the Genus *Macrosiphum* of the Family *Aphidæ*, with Special Reference to the Species Found in California," *Univ. Calif. Publ. in Entom.*, 1927, 4, No. 6, 89-158, 77 text-figs.). The nomenclature of the species of the genus *Macrosiphum* Passerini has recently undergone a revolutionary change. In the paper under review the validity of the genus *Illinoia* Wilson, which is allied to *Macrosiphum* Pass., and which is stated to comprise hereafter the great majority of the species hitherto known to belong to the latter genus, is discussed. One allied genus has been erected and four new species are described. The writer has had available for his work representatives of the great majority of the North American species that are known to belong to the genus *Macrosiphum*, together with a few species from Great Britain, Sweden, Japan, China, and India. The colour, general shape, and relative lengths of the bodies of these insects, the various parts of the body, and such other characters as may vary within the individuals of the same species, cannot by themselves be depended upon in specific classification. For this reason an endeavour has been made in this paper to harmonise the scheme of specific classification by laying more emphasis on the structural characters which are of real practical value. Such structural characters are chiefly found in the cornicles, cauda, and antennæ. An explanation in regard to the development of these organs is given. Each species described has been illustrated, because many have never been figured and others have been very inadequately shown. The failure to portray the important characters, it is stated, has been largely due to deficiency in technique. Consequently, most of the species described in this paper were thoroughly cleared before they were mounted, examined and drawn. Careful measurements in millimetres have been made of the important specific characters. With the description of each Californian species there is given also the distribution and host-plants for all North America.

M. E. M.

The Respiratory Apparatus and Respiration in Invertebrates.—PAUL REMY ("Contribution à l'étude de l'appareil respiratoire et de la respiration chez quelques invertébrés," 1-222, 8 pls., 3 text-figs., published by Ancienne Imprimerie Vagner, 33, Rue du Manège, Nancy, 1925). This large contribution to our knowledge of the processes of respiration among the invertebrates cannot be adequately reviewed in the space available, and those interested are referred to the book itself, where much interesting evidence is to be found accumulated by the author himself and other workers in the same field. The book opens with an introduction and a description of the technique employed. Chapters I-X are

concerned respectively with respiration in *Insecta*, *Diplopoda*, *Chilapoda*, *Arachnida*, *Onychophora*, *Crustacea*, *Annelida*, *Sipunculoidea*, *Echinodermata*, and the *Tunicata*. Chapter XI deals with the question "Does the nucleus play a rôle in the vital oxidation processes?" Chapter XII discusses the probable causes of the non-success, in some instances, of the injection method of leucoderivatives, while the final chapter, XIII, is devoted to the study of the intimate phenomena of respiration. A section containing the author's general conclusions follows a short *résumé* of the work, and the book concludes with a bibliography of the literature cited.

M. E. M.

Chinese Phlebotomus.—W. S. PATTON and E. HINDLE ("The North Chinese Species of the Genus *Phlebotomus* (*Diptera*, *Psychodidae*)," *Proc. Roy. Soc.*, 1928, 102, Series B, No. B720, 533-51). In an earlier paper (1926) the authors noted the more important differential characters of the adults of the three Chinese species of the genus *Phlebotomus*, but as, in 1925, they arrived too late in the country to study their early stages, they were unable to record any observations. The present paper completes the study of the three species by describing the differential characters of their early stages, and also the authors are now able to settle the status of the species with recumbent hairs, previously recorded as a variety of *P. perturbans* de Meijere. A fuller study has enabled the authors to settle the identity of the Chinese species allied to *P. perturbans*, and as it proves to be distinct from the Javanese species it is given the name of *P. taianensis*. The identity of the erect-haired species allied to *P. sergenti* Parrot, however, has not yet been settled. The paper includes a description of the egg, first and fourth larval instars, the pupa, and the adults of the genus, with notes on the distinguishing characters between them. The male and female of *P. taianensis* sp. nov. is described, and notes on the bionomics of the Chinese species of *Phlebotomus* are provided for *P. Major chinensis*, *P. sergenti* var., and *P. taianensis*. Eleven figures in the text illustrate the morphology and anatomy.

M. E. M.

The Important Specific Characters of Termites.—S. F. LIGHT ("A New and More Exact Method of Expressing the Important Specific Characters of Termites," *Univ. Calif. Publ. Entom.*, 1927, 4, No. 5, 75-88, 2 text-figs.). Several factors combine to render specific distinctions among the termites illusive and difficult to define. First is the fact that the termites are practically lacking in ornamentation, and furnish few, if any, of those satisfyingly definite differences in position or number of parts which facilitate specific diagnosis in many insect groups. Moreover, termite species are extremely plastic, and exhibit a wide range of variation. This is particularly the case in the soldier caste on the characters of which a great many species rest and on which the great majority of practical diagnoses must be based. When differences in size and proportions are the distinguishing characters, the variational range within a species becomes of prime importance. The orthodox description of a termite species involves a great many vague, loosely used, and hence misleading terms. Proportional characters one finds generally neglected in taxonomic papers on termites, or expressed by such vague and undefined terms as "long and narrow," "shorter and broader," "more than twice as broad as long," etc. It is a presentation of these differences not merely in terms of absolute size, which are often misleading, but also in terms of relative proportion of parts, which is necessary to put termite descriptions in useable form. By expressing these relations in ratios, by stating one dimension in terms of another, they become at once concrete, visible, and generally useable, serving as indices of relations or differences between the species

involved and any other species of the genus, differences otherwise lost in the vagueness of indefinite descriptive phrases. An attempt is made by the author to introduce a proportional-ratio method. The material used in this study represents the tropics of the world, including Oriental, Papuan, Australian, Madagascan, and Central American species. The characters considered are the size of the head as measured by length and the maximum and minimum breadth, head-shape as measured by the relations between these three measurements, the position of the fontanel with regard to head length, the size of the gula, and its shape and proportions as measured in terms of its own length, maximum breadth and minimum breadth, and in terms of their relations to one another, and also in terms of their relations to head length.

M. E. M.

Crustacea.

New Species of Marine Harpacticoida.—A. MONARD ("Description de quelques espèces nouvelles d'Harpacticides marins de la région de Banyuls," *Rev. Suisse Zool.*, 1926, 33, 619–28, 46 figs.). *Laophonte dinocerata*; *L. rosei*, depth 35–40 m.; *Tryphcema* (Cletodidæ between *Rhizothrix* and *Huntemannia*), based on *T. porca*; *Enhydrosoma sordidum*; *E. nigoti*; *Robertsonia diademata*, depth 35–40 metres.

Biological Abstracts.

Entomostraca of the Belle Isle Strait Expedition, 1923, with Notes on Other Planktonic Species. Pt I.—K. F. PINHEY (*Contr. Canadian Biol. and Fish.*, 1926, 3, 181–233, 8 figs.). A general taxonomic report of the sub-surface plankton in the Gulf of St. Lawrence, Strait of Belle Isle, and adjacent ocean area, including tables of the abundance of the various species at the separate stations in the area. The results show a direct correlation of the fauna with the curves of the hydrographical data, and emphasise the importance of index species in the interpretation of the origin of the water at any given locality. Of the Entomostraca 16 genera and 17 species, chiefly copepods, are represented, including *Acartia clausi* ssp. *hudsonica* and *A. longiremis* ssp. *spiniremis*. Specimens of both from the Pacific coast and of the former from Hudson Bay, formerly identified as the older species, show the same constant differences from the European and Naples types, and must therefore be included in the new sub-species first distinguished in the Strait of Belle Isle material. Holotypes in Dept. Zool., McGill Univ. *Euchirella rostrata* is reported at lat. 52° 50' N., long. 53° W. in the Labrador current north of Belle Isle, a new northern record for this species. *Diaptomus tyrelli* was identified in material from Chateau Bay, on the north shore of Belle Isle Strait, the first record so far east. Maps of the distribution of *Temora longicornis* in the Strait of Belle Isle in Aug. and Sept., and of *Anomalocera patersoni* in the same months in the Strait, the Gulf of St. Lawrence, and the ocean about Newfoundland, are included. There is a table of the occurrence of 29 non-entomostracan species in the plankton investigated (2 Dinoflagellates, 2 Ctenophores, 6 Medusæ, Echinodermata larvæ, 2 Polychætes, 1 Chætognath, 2 Gastropods, 9 Crustaceans, 3 Appendicularians, and unidentified fish eggs and larvæ).

Biological Abstracts.

The Males of *A. cancriformis* from Lake Balaton Biological Station (English Summary).—S. ABONYI ("Az Apus cancriformis Schäffer himjeiröl a Révfülöpi Balatoni Biológiai Állomás körzetében gyűjtött példányok alapján," *Archivum Balaticum*, 1926, 1, 71–90, 6 figs.). This species shows a strong sexual dimorphism. The ♂ are smaller than the ♀ and have a comparatively short

and rounded shell; the former are also more active than the latter, and swim faster. Twenty-seven p.c. of the first generation consisted of ♂, and 25 p.c. of the second and third generations; the author thinks this may represent a "mending" ratio of ♂.

Biological Abstracts.

Behaviour of *Zenobia prismatica* Risso.—A. MAURY ("Etude sur le comportement de *Zenobia prismatica* Risso," *Bull. Soc. Linn. Normandie*, 1926, 8, 89-92). Hitherto the tubicolous isopods were supposed to inhabit tubes of vegetable origin. This is true to a degree of *Z. prismatica*; at Luc-sur-Mer, however, it occupies tubes of an agglomeration of grains of sand. The tubes are probably not constructed by *Zenobia* but by tubicolous annelids. One individual was found in a *Serpula* tube. The characters of *Zenobia*, which is especially adapted to a tubicolous life, are reviewed.

Biological Abstracts.

Form Analysis in Hyperidea.—H. MOGK ("Versuch einer Formanalyse bei Hyperiden (II Teil)," *Internat. Rev. Gesam. Hydrobiol.*, 1926, 14, 160-91, 276-311, 1 pl., 25 figs.). *Phronima sedentaria* (For.) and *P. atlantica* Gué. (Amphipoda Hyperidea) are investigated by a new method to ascertain factors regulating form and mode of growth. A series of graphs showing morphogenesis of single parts and the variation of many relations of the whole body is presented. Variations of growth are readily discerned by use of the graphs, which make possible the expression numerically of each point of development of most complex forms. This method is useful in systematic discrimination of species and in following an individual through its ontogeny. The gradation curves of MacLeod, in a somewhat modified form, are also used in descriptions of species. The following results were obtained: *P. sedentaria* and *P. atlantica* are distinct species separable in both sexes at a comparatively early age. On a graph may be found the first five or six stages of each species by well-defined groups of points, furnishing a basis for a quantitative morphogenesis founded on average values. In the first stage the sexes are not distinguishable, but they become more distinct from stage to stage, although at first this is only a matter of size. The sexes are more distinct in *P. sedentaria* than in *P. atlantica* at the corresponding ecdyses. The ♂ are not only absolutely smaller than the ♀, but their increase in size is also less at each ecdysis, and they also attain sexual maturity in fewer ecdyses than do the ♀. The ♂ of *P. atlantica* become adult in eight ecdyses, those of *P. sedentaria* in seven. The increase in size in both species is least between the penultimate and the last stages. The particular development of secondary sexual characters is here connected with the age of the animals. The divergence of the two species into their typical forms takes place from the fifth stage on. In the ♀ it was possible to recognise the stages only to a limited extent. Here the new method is important for specific distinction.

Biological Abstracts.

Passive and Active Protective Structures in Gammaridae.—A. SCHELENBERG (*Zool. Anzeiger*, 1926, 68, 181-83, 2 text-figs.). In many forms there are stout, sharp spines or spurs that protect the animals from being eaten. The most typical development is in species from Lake Baikal, some of which have spines that injure the hands of fishermen. In *Cyphocaris challengeri* there is a very strong spur on the basipodite of the fifth pereopod; the spur contains glands that open near the tip. These glands are thought to form a poisonous secretion. The appendage can be moved into such a position that the spurs project laterally beyond the body and so are protective against attacks by fish.

Biological Abstracts.

Carcinological Investigations of the Lower Danube and Black Sea Regions.—O. PESTA ("Wissenschaftliche Forschungsergebnisse aus dem Gebiete der unteren Donau und des Schwarzen Meeres," *Arch. Hydrobiol.*, 1926, 16, 605–43, 34 text-figs.). The paper is divided into three parts. (1) Copepoda and Cladocera from the littoral of the Black Sea, (2) freshwater Decapoda, (3) Decapoda from the littoral of the Black Sea. The following Copepoda and Cladocera are described or commented on: *Canuella perplexa* (?), *Harpacticus niceensis* var. *pontica*, *Psamathe longicauda*, *Idya furcata*, *Microthalestris* sp., *Westwoodia* sp., *Dactylopusia thisboides*, *Mesochra* sp., *Laophonte uncinata*, *Paracalanus parvus*, *Centropages kroyeri* var. *pontica*, *Acartia clausi*, *Podon polyphemoides*. The freshwater Decapoda are *Potamobius* (*Astacus*) *leptodactylus*, and *Potamon potamios*. Only two circummediterranean species of *Potamon* are recognised: *P. fluviatile* (= *edule*) and *P. potamios* (including *P. setiger*, *ibericus* and *intermedium*). The author discusses their variation and distribution, gives an extensive table of measurements and variations, and suggests for *setiger* the designation of *P. potamios* f. *setiger*. *Pachygrapsus marmoratus*, *Xantho hydrophilus*, *Portunus holsatus*, *Carcinides mœnas*, and *Leander adspersus* are listed as littoral.

Biological Abstracts.

Pelagic Copepoda Obtained on Cruises of the Yachts of Prince Albert I of Monaco.—O. PESTA ("Sur une Collection de Copépodes pélagiques provenant des Croisières des yachts du Prince Albert Ier de Monaco," *Bull. Inst. Oceanograph*, 1926, 477, 1–23). Genera of Copepoda present in collections made in the Mediterranean Sea, Atlantic and Arctic Oceans between 1885 and 1910 are discussed. The 87 stations, all but two at the surface, are listed with location and pertinent data; notes are given on the genera taken at each station, and also on other groups of animals present. The distribution of genera is taken up in a roughly quantitative way, the genera are listed with the stations for each, and in a few cases the species involved are determined. Thirty-eight genera are reported.

Biological Abstracts.

Amphipods from North and East Spain.—H. SPANDE ("Amphipoden aus dem nördlichen und östlichen Spanien," *Senckenbergiana*, 1926, 8, 128–32, 4 text-figs.). Of the five species of fresh-water amphipods hitherto known in Spain, *Echinogammarus berilloni* Catta, shows extraordinarily great variability, not only in its growth stages but in the sexually mature whether ♂ or ♀. Variations in the abdominal segments, third uropod and telson, are described and figured. *Orchestia gammarellus* Costa (its unusual distribution is noted, to 800 m. altitude in Sicily, and 500 km. inland from the sea in North Africa) and *Talorchestia brito* Stebbing are new to the fauna.

Biological Abstracts.

Antarctic and Subantarctic Cirripedia Collected by S. Vallin.—C.-A. NILSSON-CANTELL ("Antarktische und subantarktische Cirripeden gesammelt von S. Vallin, 1923–4," *Ark. för Zool.*, 1926, 12, 1–16, 5 text-figs.). The collection in the Zool. Mus. in Lund contains seven species. Comparison with the South African fauna shows few species in common except *Tetracrita rosea* and the pelagic or more cosmopolitan forms. *Scalpellum bouvieri*, *Catophragmus polymerus*, *Chthamalus antennatus*, *Chamasipho columna*, *Elminius modestus* and *Coronula reginae*, are redescribed. New localities are recorded: for *S. bouvieri*, Ross Sea; for *C. polymerus*, Storm Bay, Tasmania; and for *C. reginae*, Ross Sea, from Blue Whale.

Biological Abstracts.

Changes of Secondary Sexual Characters in Pagurids due to Rhizocephala.—C.-A. NILSSON-CANTELL ("Über Veränderungen der Sekundären Geschlechtsmerkmale bei Paguriden durch die Einwirkung von Rhizocephalen," *Ark. för Zool.*, 1926, 13, 1-21, 9 text-figs.). Contradictions in the work of earlier authors are noted. The author finds that the secondary sexual characters of the ♂ assume the ♀ form in a varying degree. In *Anapagurus chiroacanthus*, the parasite *Pelogaster sulcatus* causes the pleopods of the ♂ to approach the form of those of the ♀. When the parasite is *P. paguri*, the pleopods are hardly affected, but the copulatory organ tends to disappear. In *Eupagurus cuanensis* both species of *Pelogaster* cause the pleopods to assume the ♀ form. The parasites seemed to have no effect on secondary sexual characters of the ♀ of either hermit crab. Large and small ♂ appeared to be equally affected. *Biological Abstracts*.

Echinodermata.

Echinoderms from the Chalk of Spain.—J. LAMBERT ("Note sur quelques échinides du crétacé d'Espagne," *Bol. de la real. soc. españ. de Hist. nat.*, 1928, 28, 147-57, 1 pl.). A series of echinoderms coming from the eocretaceous strata of Castellón and Morella is described. G. M. F.

Nemathelminthes.

Nematoda.

On New Species of Nematodes from Fishes of Lake Biwa.—T. FUJITA (*Jap. J. Zool.*, 1927, 1, 169-76, 5 text-figs.). 38 p.c. of 125 fishes of 19 genera and 20 species collected from Lake Biwa were found parasitised by worms, the majority of which occurred in the visceral cavity or in the alimentary canal. 60 p.c. of these were nematodes comprising 10 new species, five of which are described and figured here. The first three of these, *Procamallanus parasituri*, *Camallanus cotti*, and *Rhabdochna salvelini*, have been named after the fish host. The species name of *Cucullianus gigi* from *Fluviodraco nudiceps* is given provisionally only. The fifth species is *Spinitectus gigi* from the same host. J. L.

The Effect of Sea Water on the Development of Hookworm Ova and Larvæ.—FRED C. CALDWELL and ELFREDA L. CALDWELL (*Journ. Parasitology*, 1927, 13, 270-82). During a survey of 593 San Blas Indians whose habit was to defæcate into the sea below low tide, it was found that only 4.7 p.c. were infected with hookworms, while these were present in 65.8 p.c. of non-Indians among whom soil pollution was the rule. Various laboratory experiments conducted with a view to explaining these facts showed (a) that the lethal effect of saturation with sea-water was 600 times as great as that of water; (b) that the average larval yield of cultures made under optimum conditions and moistened with sea-water was 0.116 p.c., in contrast with 67.6 p.c. in cultures moistened with ordinary water; (c) that there was a low larval yield when cultures submerged under sea-water for more than one day were subsequently transferred to favourable conditions. Here it was thought that ova and larvæ were affected by the residual salt in the fæces. Quantitative experiments showed that under optimum conditions sea-water does not prevent the development of hookworm eggs to the embryonated stage, but retards hatching and kills newly-hatched larvæ. J. L.

Studies on the Rate of Development and Viability of the Eggs of *Ascaris lumbricoides* and *Trichuris trichiura* under Field Conditions.—H. W. BROWN (*J. Parasit.*, 1927, 14, 1-15, 2 text-figs.). Cultures of *Ascaris* eggs were made on sand, loam, clay, and humus soils, both in sun and shade, at

Penomnoe, Panama. All the eggs became embryonated within 15 days except those in sand, which in sun produced no embryonated eggs, either of *Ascaris* or of *Trichuris*, and all of which had degenerated after 21 days, and in shade underwent a gradual degeneration after reaching a maximum development at 35 days. Development in the humus cultures was at least 20 days slower than in the others. The experiments showed that soil was an important factor in the rate of development and viability of *Ascaris* and *Trichuris* eggs, and that it was thought that as the temperature and rainfall of the Southern United States was very similar to that at Penomnoe, the development of these ova in the States in sandy soils may be much more rapid and the longevity shorter than is generally supposed.

J. L.

The Prevention and Treatment of Carbon Tetrachloride Intoxication.—

P. D. LAMSON, A. S. MINOT and B. H. ROBBINS (*J. Amer. Med. Assoc.*, 1928, 90, 345-49). Although in doses of 2.5-3 cc. CCl_4 has been proved to be 95-100 p.c. successful in vast numbers of cases of *Necator* (slightly less so with *Ancylostoma*), toxic symptoms have occasionally followed on treatment with this drug. On investigation these have been found to arise in the following cases, all of which are avoidable or are susceptible of treatment. (1) Alcoholism. It is recommended that chronic addicts should be refused treatment. (2) When taken after a heavy meal. The drug should always be taken on an empty stomach, and both alcohol and food, especially fatty food, should be avoided both immediately before and after treatment. (3) When a heavy *Ascaris* infection is also present. The irritation, and mechanical respiratory and intestinal obstruction, are the result of the increased activity of the worms caused by the drug. This complication can be avoided by a preliminary treatment with oil of chenopodium. (4) The majority of cases of intoxication which are not due to the above causes, and especially those of children, are due to calcium deficiency. There is generally a latent period of 24-36 hours, followed by nausea and vomiting, which may be uncontrollable. Prevention should aim at building up the calcium reserve in poorly-nourished children by supplying milk, calcium salts, parathyroid, etc., in the diet. The authors observe that these are the results of experiments on dogs, but that theoretically there should be the same response in man.

J. L.

Are *Ascaris suilla* and *Ascaris lumbricoides* Identical?—FRED. C. CALDWELL and ELFREDA L. CALDWELL (*J. Parasit.*, 1926, 13, 141-45). A survey was made in the sandy coastal plain of Alabama, in a region where all conditions appeared to be favourable for cross-infestation between the pig and man. Although the incidence in pigs was found to be 46.5 p.c., human infestation was less than 1 p.c., which adds epidemiological evidence to the view that the two species are not identical. Variations in soil as a possible distribution-limiting factor were now being investigated.

J. L.

The Relation of the Type of Soils of Alabama to the Distribution of Hookworm Disease.—DONALD L. AUGUSTINE and WILSON G. SMILLIE (*Am. J. Hyg.*, 1926, 6, 36-62). Cultural experiments showed that the development of hookworm larvæ was directly related to the physical texture of the soil, the largest number being recovered from sandy soil, and the smallest from clay. Actually it was also found that hookworm infestation of children in the neighbourhood of Alabama was heaviest in the two sandy provinces, upper and lower coastal plains, and, indeed, was largely limited to the latter, while children living in areas of heavy clay soils showed never more than slight infections.

J. L.

Accuracy in the Dilution Egg-Counting Method.—NORMAN R. STOLL and WALTER C. HAUSHEER (*Am. J. Hyg.*, 1926, 6, 80-133). The authors' aim has been to compare the number of ova secured by the dilution egg-counting method with that obtained by the direct centrifugal flotation method, using identical portions of faeces containing hookworm eggs. As the result was invariably higher with the dilution method, this is considered to be the more accurate. A considerable quantity of data is given and the two methods are compared and discussed in detail. It is considered that the lower figure obtained by the direct centrifugal flotation method may be due to the following causes: destruction of ova by the saturated salt solution, the difficulty in counting large numbers on a coverslip, where a re-check is impossible owing to the rapid crystallisation of the salt solution, and also the possibility that the salt does not remove the stickiness of the ova. Where discrepancies occur with the dilution technic these are generally the result either of inadequate mixture of the stool, failure to withdraw the proper sized drop of the homogeneous mixture immediately after shaking, or to inaccurate counting.
J. L.

A Study of the Regularity of Egg-Production of *Ascaris Lumbricoides* *Necator americanus* and *Trichuris trichiura*.—H. W. BROWN (*J. Parasit.*, 1927, 14, 110-19). All three species studied produced eggs with about equal regularity. Any difference in the regularity of one species could be explained as due either to the size of the infestation, or to some irregularity of the hosts functioning rather than irregularity of worm functioning.
J. L.

An Experimental Study of the Development of *Ancylostoma caninum* in Normal and Abnormal Hosts.—J. ALLEN SCOTT (*Am. J. Hyg.*, 1928, 8, 158-204, 6 text-figs.). In order to discover the conditions necessary in a host for the development of *Ancylostoma caninum*, and, incidentally, the development of the parasite in various hosts, infective larvæ were fed to dogs, cats and rats. It was found that both cats and dogs became more resistant with advancing age, although cats were never as susceptible as dogs. Rats were entirely insusceptible. A certain number of worms always remained undeveloped, and could be recovered from the organs several weeks after administration. While in cats and dogs they were present as late as the 44th and 33rd days respectively, in rats they were not recovered after the 21st day. These worms were identical with the infective larvæ administered, and were still motile and infective. There was a constant rate of decrease, which was more rapid for rats than cats and dogs, in the number of undeveloped worms recovered, with the lengthening of the time after the infection. Numbers were seen to pass out in the faeces of rats. Development, it was found, could take place without passing through the lungs, the migration being more frequent in rats than in dogs and cats. These results seemed to show that a combination of factors was responsible for making the environment of varying favourability to the parasite, and that the parasite itself varies in its ability to take advantage of this varying environment.
J. L.

A Quantitative Study of Infections with *Ancylostoma caninum* in Dogs.—C. A. HERRICK (*Am. J. Hyg.*, 1928, 8, 125-57, 2 text-figs.). A study has been made of the ratio of eggs produced to the number of females, the factors influencing the course of the infestation, and the relations of previous infections to the resistance of the host. Important factors influencing the egg-worm ratio were found to be the age of the worms, the proportion of worms found in copulation, and the proportion males to females. The number of eggs produced by the female increased considerably with age. Although the average number of eggs per gramme

per female was found to be 440, it was considered that the average number of eggs per day (10,000) was a better measure of infestation, as it was less variable and was more accurate in estimating females. Older dogs were shown to be more resistant to infections than younger ones. They did not show an increased resistance to infection when a previous infection was removed by anthelmintics, although in superimposed infections there was some degree of resistance after a second or third infection. Egg production was at its maximum 15-20 days after the appearance of the first egg in the stool, and then greatly decreased until a general level was established. J. L.

Concerning two Options in Dilution Egg Counting: Small Drop and Displacement.—NORMAN R. STOLL and WALTER C. HAUSHEER (*Am. J. Hyg.*, 1926, 6, 134-145, 1 text-fig.). It is found that in Stoll's dilution egg counting technic drops of 75 cmm. (instead of 150 cmm.) are best. To obtain the number of eggs per gramme the average of two such counts is multiplied by 200, or the sum of two small drop counts is multiplied by 100. A second modification lies in the use of quantities of faeces measured by displacement in the dilution tube, instead of weighed samples, i.e., using eggs per cc. as a basis (rather than eggs per gramme), as it gives a somewhat higher count. The apparatus required for this procedure is described, and consists of a pyrex 50 cc. Erlenmeyer flask with a neck 6.5 cm. long and having an inside diameter 20-22 mm. The neck is ringed at the 56 and 60 cc. marks, and the whole is stoppered with a No. 4 solid rubber cork. When beads are added there is still 2 cc. shaking space.

A Dilution-Flotation Technic for Counting Hookworm Ova in Field Surveys.—FRED. C. CALDWELL and ELFREDA L. CALDWELL (*Am. J. Hyg.*, 1926, 6, 146-59). In order to free the ova from mucous, use was made of antiformin, and for concentrating the ova sugar solution was found to be most suitable, as it retarded the movements of debris and ova due to gravity. It should be used in the proportions of one part of faeces to 10 parts of diluent in the case of formed and soft faeces, or 2-10 in the case of very mushy or diarrhoeic stools. The technique is as follows:—Four grammes of faeces are weighed by difference and placed in a flask, and 4 mil. of 30 p.c. antiformin stirred in, and the whole (including stirring rod) allowed to stand for an hour or more. Sugar solution of 1.230 sp.g. is then added to the 40 mil mark. After further stirring the rod is removed and a suspension secured by bubbling through a bacteriological pipette laced against the bottom of the flask. 0.1 mil of the suspension is then withdrawn, and spread on a slide and examined without a coverslip. The number of eggs present multiplied by 100 equal the number of eggs per gramme. J. L.

Platyhelminthes.

Trematoda.

Studies on the Trematode Family Strigeidæ (Holostomidæ), No. 7. *Tetracotyle pipientis* Faust.—R. CHESTER HUGHES (*Trans. Am. Micr. Soc.*, 1928, 47, 42-53). This study is based on one co-type specimen and on numerous specimens from frogs (*Rana pipiens*) from Palas Park, near Chicago, and from Ann Arbor. The cysts occurred either singly or in grape-like clumps, and were found to be most abundant near the bladder and in the pericardial cavity. These parasites are described, and the author considers them to be identical with *Tetracotyle pipientis* Faust, but finds that they disagree with his description in certain

points. These are discussed, and the species is contrasted with *Tetracotyle crystallina* Rudolphi, the only other tetracotyle from amphibians. J. L.

Studies on Asiatic Holostomes.—ERNEST CARROLL FAUST (*Rec. Ind. Mus.*, 1927, 29, 215–27, 8 pls., 21 figs.). Fifty specimens of an unusual form, *Cleistogamia holothuriana* Faust, 1924, were obtained from the intestine of the Holothurian *Actinopyga mauritiana* from the Andaman Sea. In this species, which is unique in having an invertebrate host, the seminal vesicle and the uterus have no external opening, a filament passing from the seminal vesicle and uniting with the vagina. This, then, is a case of cleistogamy, or obligatory self-fertilisation, a process apparently hitherto unrecorded in the animal kingdom as a sole means of fertilisation. The egg is unique for holostomes in having at one end a long polar filament which may be coiled, and may serve either in rupturing the uterus or as a means of attachment for the eggs when liberated. The intermediate host is unknown, but is probably a marine mollusc. Trematode cysts from the subcutaneous tissue and superficial muscles of several species of food fish collected from Kashmir and Seistan are described, and were found to comprise three new species: *Diplostomum schizothoracis* from *Schizothorax zarudnyi*, *Strigea annandalei*, from *Nemachilus rupiculus*, and *Neodiplostomum kashmirianum*, from *Schizothorax curvifrons*, *S. niger*, and *Crossochilum latia*. All showed a relatively advanced condition of the genital rudiments, and must have undergone considerable development after encystment. The occurrence in Asia of *Pharyngostomum cordatum* was recorded by the finding of the adults in domestic cats in China by the author, and later by Dr. Ke-Fang Yao. It has now been found that the encysted larvæ which are here described occur in two species of local fish, and, when fed experimentally to a cat, gave rise to typical adults. J. L.

Two New Genera of Fish Trematodes.—Y. OZAKI (*Jap. J. Zool.*, 1927, 1, 157–64, 7 text-figs.). Fifty-two specimens of the first new genus *Isococelium*, were recovered from the intestine of *Uranoscopus japonicus* at Tatkamatsu, Japan. Of 32 examined 12 were found to be infected. The specimens most nearly resembled *Anisococelium* and *Anisogaster*, but differ from them in the position of the testes, which are posterior and oblique, and of the yolk glands, which lie in front of one another behind the ovary in the mid-region of the body. Hence the specific name *I. mediolecothale*. *Urorchis goro*, g. nov. sp. nov., which was found in the intestine of *Tridentiger obscurus*, bears a certain resemblance to the members of the sub-family Philopthalminæ Looss, 1899, but can be separated from it on the following characters: (1) the lateral displacement of the genital pore; (2) the presence of a receptaculum seminalis; (3) the long cesophagus; (4) the form and distribution of the vitellaria. J. L.

Furcocercous Cercariæ.—H. M. MILLER, JR. ("Comparative Studies on Furcocercous Cercariæ," *Illinois Biol. Monogr.*, 1926, 10, 3–112, 8 pls., 2 text-figs.). The morphology and behaviour of seven species of furcocercous cercariæ are described and detailed comparison made with morphologically similar cercariæ. The literature of furcocercous cercariæ is critically reviewed, and a classification formulated to include the 100 odd species of freshwater forms. Re-study of North American larvæ (*C. douthitti*, *C. elephantis*, *C. echinocauda*, *C. gigas*) makes possible their more exact disposition. Well-defined groups are found only among the apharyngeal brevifurcate cercariæ. While the classification is largely based on the excretory system in the cercaria, due emphasis is also placed on other features of morphology. The scanty data on the life-histories of furcocercous cercariæ are

reviewed. A complete check list of both freshwater and marine larvæ is given: *Cercaria burti* parasitic in *Planorbis trivolvis*, *C. chrysenenterica* in *Lymnæa megaloma*, *C. elvæ* in *L. stagnalis* var. *appressa*, *C. hamata* in *P. trivolvis*, *C. multicellulata* in *Physa gyrina*, *C. tenuis* in *P. trivolvis*, *C. wardi* in *P. trivolvis*.

Biological Abstracts.

Morphological, Systematic and Developmental Studies on the Species of *Sanguinicola*.—L. EJSMTÖN ("Badania morfologiczne, systematyczne i rozwojowe nad gatunkami rodzaju *Sanguinicola* Plehn," *Bull. Internat. Acad. Polonaise Sci. et Lët. Sci. Nat.* (1926), 1925, 877-966, 4 pls., 16 figs.). Three species of *Sanguinicola* from cyprinid fishes are described in detail (*S. inermis* from *Cyprinus carpio*, *S. armata* from *Tincta tincta*, and *S. intermedia* from *Carassius carassius*). They occur most commonly in the heart and bulbus arteriosus, liver and its blood-vessels, kidney, and blood-vessels of the pleuropéritoneum. Eggs and free-swimming miracidia occur in the circulating blood. Members of the genus are very small trematodes, maximum length 1.5 mm., transparent, active, of variable shape—generally lanceolate. The excretory system consists of four pairs of flame cells and the collecting tubules and ducts. There are 10 to 15 pairs of testes. There is no uterus, seminal receptacle, or Laurer's canal. The genus is not protandric, as supposed by Plehn. The eggs have no lid. The miracidia pass to the exterior through the gills. Sporocysts occur in the snails *Limnæa stagnalis* and *Bithynia leachii*. The cercaria has long been known under the name of *C. cristata*. A table is given of the characters of the three families of blood flukes—Aporocotylidæ, Spirorchidæ, and Schistosomidæ—and the characters are compared. Woodland's description of *S. chalmersi* Odhner from silurid fishes of the Nile is criticised, numerous errors pointed out, and the agreement between the characters of this species and those of the European species noted.

Biological Abstracts.

Cœlenterata.

The British Edwardsiæ.—O. CARLGREN and T. A. STEPHENSON (*J. Marine Biol. Assn.*, 1928, 15, 1-31, 18 text-figs.). No adequate account of the British Edwardsiæ at present exists. They are regarded as a family of ordinary Actinaria with few mesenteries. The British species, of which details are given, are *E. callimorpha* Gosse, *E. delapiezæ* n. sp., *E. tecta* Haddon, *Milne-Edwardsia carnea* Gosse, *Milne-Edwardsia dixonii* Carlgren. The succession of tentacles in *E. callimorpha* is described, while the regions of the columns in Edwardsiæ and other Actinians is discussed.

G. M. F.

Pseudopercula in the Tabulate Coral Favosites.—C. O. DUNBAR (*Am. J. Sci.*, 1927, 13, 101-14, 9 text-figs.). Calcareous membranes closing the apertures of the lower corallites in certain favosite corals have been described repeatedly as opercula. Such structures are here described and figured in *Favosites radiatus* Rom., *F. forbesi* Hall, *F. billingsi* Rom., *F. turbinatus* Bill., *F. placenta* Rom., and *F. clausus* Rom., in all of which they are interpreted as specialisations of the epitheca permanently closing abandoned corallites. The name pseudopercula is proposed for them. Four lines of evidence indicate that they are not true opercula: their occurrence on the basal or lateral corallites and not on those of the growing summit of the corallum, complete lateral gradation from the operculiform covers into wrinkled epitheca, the absence of opercular structures beneath the wrinkled epitheca, and the shallow calyces, and frequently thickened walls, of the covered corallites.

Biological Abstracts.

Graptolite Discoveries in the Sierra Morena.—W. HENKE and R. HUNDT ("Bericht über einige Graptolithenfunde in der Sierra Morena," *Abhandl. Senckenberg. Naturforsch. Ges.*, 1926, 39, 205–13). Graptolites, collected from outcrops, mine dumps and mine levels at several localities in the Sierra Morena in the general vicinity of La Carolina, are, with one exception, all of Silurian age, to be correlated with the Llandovery, Tarannon and Wenlock of England. The material from north of Venta de Cardenas contains *Didymograptus bifidus* Hall, which correlates this bed with the Llandeilo, classing it as of Lower Ordovician age (Canadian in American usage). *Biological Abstracts.*

Porifera.

German Freshwater Sponges.—W. ARNDT ("Bau und Leben der deutschen Süsswasserschwämme. Mit einer Bestimmungstabelle der bisher in Europa gefundenen Formen," *Mikrosk. f. Naturfreunde*, 1926, 4, 119–32, 2 pls., 9 text-figs.). Introduction to the anatomy and physiology of the Spongillinae of Germany, including an enumeration of the fossil species. Habitus-photographs of certain forms are given. *Spongilla lacustris* has oscular "chimneys" projecting $\frac{3}{4}$ –1 cm. which contract to a barely perceptible hump when stimulated; the reaction time for this movement was found to be 5 to 10 min. Chemical analysis of dried *S. lacustris* showed a relatively high iron content. Facts are given concerning the use of freshwater sponges in medicine. The technique employed in determining spongillid species is explained. The key covers the known forms (28) of Europe, including fossil species. *Biological Abstracts.*

Protozoa.

Survival in *Paramecium caudatum*.—E. C. MYERS ("Relation of Density of Population and Certain Other Factors to Survival and Reproduction of Different Biotypes of *Paramecium caudatum*," *J. Exp. Zool.*, 1927, 49, 1). This paper deals with the effects of the density of population on survival, reproduction, and extinction in colonies of *Paramecium caudatum*. When a certain number of parent individuals are introduced into the culture, the population increases to a maximum and subsequently declines until the animals become extinct. The relative rate of both increase and decrease depends upon the density of the individuals in the medium. If the actual volume of fluid per individual is sufficiently large, the volume and the number can be altered throughout a wide range without altering the rate of reproduction. A decrease in the volume of fluid for the same initial number of individuals decreases the period during which reproduction occurs, decreases the life in the culture and therefore the number of fissions which take place. Hay infusion inoculated with bacteria from an already thriving culture is more favourable to reproduction when two days old than either earlier or later. In fresh infusions a long period of 24 hours or more occurs, and this is not found when the fresh infusion is inoculated. Cultures in which *Paramecium caudatum* have lived and died are more toxic than the same cultures without Paramecia. It appears, therefore, that some portion of the toxic effect is due to the fact that *Paramecium caudatum* have lived in the culture, and that the remainder of the toxic effect is due to the presence of bacteria. A. S. P.

Monsters in *Paramecium caudatum*.—C. F. DE GARIS ("The genetic study of *Paramecium caudatum* in Pure Lines through an Interval of Experimentally Induced Monster Formation," *J. Exp. Zool.*, 1927, 49, 133). Double monsters can be produced in *Paramecium caudatum* as the result of the action of a retarding agent at a critical period of development for an adequate time. The production

of such monsters in pure lines of *Paramecium* changes neither the fission rate nor the mean cell length which characterises the line in question. These two indices are delicate measures of the genotype, and this result, therefore, suggests strongly that the genotype remains unchanged by the formation of double monsters.

A. S. P.

Encystment of *Paramecium*.—L. R. CLEVELAND ("The Encystment of *Paramecium* in the Recta of Frogs," *Sci.*, 1927, 66, 221-2). After rectal infection of cultures of *paramecium*, encystment takes place in 2 p.c. of the frogs injected.

G. M. F.

Ingestion of *Paramecium* by Cockroaches.—L. R. CLEVELAND ("Natural and Experimental Ingestion of *Paramecium* by Cockroaches," *Sci.*, 1927, 66, 222-3). Cockroaches ingest *paramecia* naturally: the *paramecia* are usually killed after six hours in the stomach.

G. M. F.

Cultivation of *Trichomonas buccalis*.—H. C. HINSHAW ("Cultivation of *Trichomonas buccalis*, a Protozoan of the Human Mouth," *Univ. of Cal. Publ. in Zool.*, 1927, 31, 31-51.) *T. buccalis* will survive 0° C. for 48 hours, 10° C. for 72 hours, room temperature for 3-6 days, 45° C. for 9-11 minutes, and 47.5° C. for 7-9 minutes. The split products of a number of proteins may be utilised by *T. buccalis*. The simplest medium yielding growth was a pancreatic digest of sodium caseinate highly diluted with Locke's solution, forming a 0.5-1 p.c. solution. Carbohydrates may be omitted, but bacteria are essential for the isolation of this protozoan. Contamination of cultures by certain bacteria has resulted in a great acceleration of growth. Many other bacteria are decidedly antagonistic to this flagellate "in vitro."

G. M. F.

The Viability of *Endamoeba gingivalis*.—D. A. KOCH ("Relation of Moisture and Temperature to the Viability of *Endamoeba gingivalis* (Gros) in vitro," *Univ. of Cal. Publ. in Zool.*, 1927, 31, 17-29, 2 text-figs.) Immersion in water at 60° C. or above is a rapid and convenient method of sterilising against *E. gingivalis*. From 15°-40° C. survival is possible for an indefinite time. At 45° C. death occurs in 20 minutes.

G. M. F.

A New Foraminiferal Genus from the Upper Cretaceous.—J. A. CUSHMAN and R. T. D. WICKENDEN (*Contrib. from Cushman Lab. for Foraminiferal Research*, 1928, 4, 12-13). The new genus *Neobulimina* is closely related to *Bulimina*, but shows additional characters. The type species is *N. canadensis*.

G. M. F.

An Outline of a Revision of the Polymorphinidæ.—J. A. CUSHMAN and YOSHIKI OZAWA (*Contrib. from the Cushman Lab. for Foraminiferal Research*, 1928, 4, 13-21, 1 pl.) The family is divided into two sub-families—Polymorphininae and Ramulininae.

G. M. F.

Additional Genera of the Foraminifera.—J. A. CUSHMAN (*Contrib. from the Cushman Lab. for Foraminiferal Research*, 1928, 4, 1-8, 1 pl.) Eleven new genera are described and figured.

G. M. F.

Apertural Characters in the Lagenidæ.—J. A. CUSHMAN (*Contrib. from the Cushman Lab. for Foraminiferal Research*, 1928, 4, 22-5, 1 pl.) Study of the apertural characters seems to show that in the Lagenidæ coiled forms are, as a rule, primitive.

G. M. F.

A New Genus, *Depratella*, and its Relation to *Endothyra*.—YOSHIAKI OZAWA (*Contrib. from the Cushman Lab. for Foraminiferal Research*, 1928, 4, 9–11.) *Depratella* might be derived directly from *Endothyra* by being axially elongated and losing the arenaceous nature of the test. *Depratella* is known hitherto only from the Permian rocks of Asia and North America: it appears to come from *Endothyra* in the lower Permian. G. M. F.

The Separation of *Tritrichomonas* from Bacteria.—L. R. CLEVELAND ("The Separation of a *Tritrichomonas* of Man from Bacteria: its Failure to Grow in Media Free of Living Bacteria: Measurement of its Growth and Division Rate in Pure Cultures of Various Bacteria," *Am. J. Hyg.*, 1928, 8, 257–78, 1 text-fig.). The title summarises the contents of the paper. G. M. F.

***Tritrichomonas fecalis* nov. sp. of Man.**—L. R. CLEVELAND ("*Tritrichomonas fecalis* nov. sp. of Man: its Ability to Grow and Multiply Indefinitely in Fæces Diluted with Tap Water and in Frogs and Tadpoles," *Am. J. Hyg.*, 1928, 8, 232–56, 3 pls.). This organism was obtained more than 40 times during three years from a single individual (male). When the fæces were examined directly, no flagellates were seen; but if the fæces were diluted with tap water, the organism appeared 15 to 25 days later. It constantly possesses three anterior flagella. G. M. F.

Tertiary Foraminifera of Victoria, Australia.—F. CHAPMAN and W. J. PARR ("The Balcombian Deposits of Port Phillip," *J. Linnean Soc.*, 1926, 36, 373–99, 5 pls.) The present instalment of a description of the Balcombian foraminifera of Port Phillip comprises the whole of the Lagenidæ and deals with 86 species and varieties, of which one species and one variety are described as new. Many of the already known forms have not previously been recorded from this area. G. M. F.

The Cleaving of Ciliates by *Amœba*.—C. D. BEERS (*Sci.* 1926, 64, 90). Evidence is cited that *Amœba* pinches ciliates in two by pseudopodial pressure, as Mast, Root and Beers have claimed. The author opposes the view of Schaeffer that ciliates may have pinched themselves in two following slight injury initiated by pressure of the pseudopodia. *Biological Abstracts.*

Results of Using Silver Methods on Ciliates.—B. M. KLEIN ("Ergebnisse mit einer Silbermethode bei Ciliaten," *Arch. Protistenk.*, 1926, 56, 243–79, 33 text-figs.). Employing his Ag-impregnation method, the author studied about 18 ciliates and finds in the ectosarc a well-defined reticulum which darkens by this method and which is more or less definitely connected with the basal granules of the cilia. He suggests that this "silver line system" may serve for impulse transmission, and to connect the basal granules mechanically. *Biological Abstracts.*

***Lophomonas striata* Bütschli.**—R. KUDO ("A Cytological Study of *Lophomonas striata* Bütschli," *Arch. Protistenk.*, 1926, 55, 504–15, 2 pls., 3 text-figs.). *L. striata* was found in 29 p.c. of 1,400 *Blatta orientalis* and in two out of 30 *Periplaneta americana*. It is a commensal. *L. sulcata* Schuster is probably identical with *L. striata*. The food of the flagellates consists of fluid matter present in the colon of the host. The ectoplasm is differentiated into rods and a ground mass. The axial structure consists of a bundle of axial filaments, each of which, after passing through a blepharoplast, is continuous with the flagellum. The anterior end of the bundle opens into a funnel-like calyx inside of which is a nucleus.

Nuclear division is intermediate in form between mitosis and amitosis in which chromosomes or spindle fibres do not appear. The parademesome is a part of the blepharoplasts and develops into two bundles of axial filaments. The nucleus of the cyst undergoes division once and forms two daughter nuclei.

Biological Abstracts.

A Myxosporidian Parasite of *Catostomus commersonii*.—R. KUDO ("On *Myxosoma catostomi* Kudo, 1923, a Myxosporidian Parasite of the Sucker *Catostomus commersonii*," *Arch. Protistenk.*, 1926, 56, 90–115, 3 pls.). This myxosporidian (Cnidosporidia) was obtained from a large tumour in the muscular tissue of a dead sucker. The multinucleate vegetative individual, enclosed in the host tissue, has two kinds of nuclei: vegetative nuclei, located particularly in the peripheral zone, which divide amitotically to produce either kind; and smaller, denser, generative nuclei which contain a greater number of chromatin granules and a chromatic nucleolus, and divide by a process of mitosis which involves the construction of a spireme and four chromosomes, but no spindle fibres or centrosomes. Each generative nucleus, with its enclosing island of cytoplasm, develops into a pansporoblast, from which spores mature (ordinarily two, sometimes one), after a series of nuclear divisions, in the later of which nucleoli are extruded into the cytoplasm. The oval, flattened spore, which is covered by two ridged valves, possesses two anterior polar capsules and a large sporoplasm, in which there is no iodophilous vacuole. The two nuclei of the sporoplasm fuse before emergence of the amœbula, which thus may bring about auto-infection.

Biological Abstracts.

Larval Stages in a Protozoon.—M. M. METCALF (*Proc. Nation. Acad. Sci. U.S.A.*, 1926, 12, 734–37). The name *Opalina larvarum* Metcalf, given provisionally to a species in tadpoles of *Rana clamitans*, is definitely confirmed. This *Opalina* infects the tadpoles only, not passing through the metamorphosis into adult frogs. After conjugation its zygote passes through several larval stages, living for some weeks and reproducing asexually, in each stage, being successively a *Protoopalina*, a *Cepedea*, a broad *Opalina*, and finally a narrow *Opalina*, thus confirming conclusions as to the evolution of the Opalinidæ previously drawn on anatomical grounds. Tadpoles (not adults) of *Rana catesbeiana* carry an as yet unnamed *Opalina*, the sequence of whose larval stages is *Protoopalina*, *Zelleriella*, *Opalina* of the broad sub-genus, and finally *Opalina* of the narrow sub-genus. Reference is made to the evolution of the Opalinidæ as a shuffling of four separately inherited trends.

Biological Abstracts.

Reproductive Phenomena in *Diffugia*.—P. PATEFF ("Fortpflanzungerscheinungen bei *Diffugia mammillaris* Penard und *Clypeolina marginata* Penard," *Arch. Protistenk.*, 1926, 55, 516–44, 2 pls., 8 text-figs.) *D. mammillaris* lives in an oval, somewhat flattened shell with a wart-like process at the posterior end. Besides the spherical nucleus there is a surrounding mass of chromidial substance. In binary fission a rounded mass of protoplasm protrudes from the opening and begins to take up sand grains, which become arranged regularly on its surface in the form of the shell; these are cemented together, and most of the protoplasm then flows back into the old shell. Nuclear division begins after completion of the shell. The nucleus moves forward, becomes a spindle with a splitting equatorial plate. The nuclear membrane remains intact; no centrioles were observed. Reconstructed nuclei and clumps of chromidial substance are distributed when the protoplasm flows from shell to shell two or three times. Division in *D. pyriformis*

and *D. molesta* is, with minor differences, similar to the above. In copulation two individuals become united by their mouth openings, uniting in one shell, the other being discarded. The nuclei remain separate. The shell of *Clypeolina marginata* consists of two flattened valves of organic substance with imbedded sand grains and other objects. The rhizopod has fine pseudopodia, a chromidial mass, and a nucleus similar to that of *Diffugia*. At the time of division sand grains are collected in a heap at the mouth opening and the valves separate anteriorly, forming a cleft into which the construction material enters. A new valve then forms opposite each old one. Nuclear division is similar to that of *Diffugia*. In copulation two individuals attach by their anterior ends and incline toward their broad sides. The inner valves of this angle fuse from the anterior end back, the edges remaining separate so that the rim of the resulting copula is double. Plasma bodies fuse, all foreign particles are extruded, and a cyst membrane is formed. The nuclei remain separate. In one case three individuals formed a trinucleate copula. In *Euglypha alveolata* the two nuclei of the copula also remain separate. A review is given of methods of conjugation, copulation, etc., in freshwater shelled rhizopods. *Biological Abstracts.*

Globigerina Ooze.—HISAKATSU YABE and SHÔSHIRÔ HANZAWA ("Globigerina Ooze from the Sea Lying South of Okinawa-Jima (the Riukiu Islands)," *Jap. J. Geol. and Geogr.*, 1926, 4, 47-54, 1 text-fig.). Nine samples were examined and the foraminifera are listed, with the frequency at each of the stations. The area involved extends from N. lat. 25° 38' to 25° 60', and from E. long. 127° to 127° 30'. The study was made to obtain data for comparison with the late Tertiary deposits of the same region. *Cassidulina alternans* is described. *Biological Abstracts.*

BOTANY.

(Under the direction of A. B. RENDLE, D.Sc., F.R.S.)

GENERAL.

Cytology.

A Haploid *Nicotiana Tabacum*.—R. H. CHIPMAN and T. H. GOODSPEED ("Inheritance in *Nicotiana Tabacum*. VIII.—Cytological Features of *Purpurea Haploid*," *Univ. California Pub. Bot.*, 1927, 11, 141–58). The *N. Tabacum purpurea* haploid plant appeared in a population of F_1 *purpurea-sylvestris* and resembled the female parent, presumably affording an example of true parthenogenesis. The haploid is completely female sterile, though capable of producing viable pollen which contains the full haploid chromosome set of *purpurea*. The meiotic stages of the *purpurea* diploid and haploid types are compared. Prophasic stages in the haploid show an entire absence of the orderly seriation exhibited by the diploid in any given pollen sac. Pre-synizetic stages are similar in both forms, the leptotene thread being a continuous and single structure. The pachynema in both is also at first a continuous thread. Doubling of the pachynema occurs in the diploid form, followed by rapid condensation and second contraction with no conspicuous looping of the shortening threads. An ill-defined strepsinema is sometimes observed. Twenty-four bivalent chromosomes are apparent at diakinesis which is followed by a third contraction. No evidence of a third contraction is found in embryo sac mother-cells. The single pachynema of the haploid variety undergoes no process of doubling, but condenses into 24 univalent chromosome lengths. Second contraction occurs with no evidence of pairing, and, at "diakinesis," 24 short unsplit chromosomes lie at the periphery of the nucleus. Both heterotypic and homotypic divisions occur normally in the diploid form, resulting in normal tetrad formation. In the haploid, division of all 24 chromosomes may occur, the halves apparently preparing to pass in normal manner to the daughter nuclei. Such division results in the formation of dyads and the production of viable pollen grains containing the full set of *N. Tabacum purpurea* chromosomes. Random distribution of the 24 univalents is also observed, some undergoing division or lagging, and resulting in a wide range of types of chromosome distribution at interkinesis. A large proportion of the homotypic divisions results in the formation of tetrads whose cells are of approximately equal size. This evidence of lack of pairing in the haploid *Tabacum* set of chromosomes is significant in supporting the proof of the occurrence of the "Drosera scheme" of pairing in F_1 *sylvestris-Tabacum* hybrids. J. L.

X-Rays on *Nicotiana*.—T. H. GOODSPEED and A. R. OLSON ("The Production of Variation in *Nicotiana* Species by X-Ray Treatment of Sex Cells," *Proc. U.S. Nat. Acad. Sciences*, 1928, 14, 65–9). Plants of *N. Tabacum* var. *purpurea* bearing numerous flower buds of all ages were submitted to doses of

X-rays. The details of the dosage are given. Over 1,000 plants have been raised from seed produced by allowing the X-rayed buds to self-pollinate. About 50 p.c. of these plants are variants from typical *purpurea*, and no two show identical abnormalities. The morphological differences chiefly concern the size of plant, the size, form and colour of leaf and flower. Most of the variants show reduced fertility, but are rarely completely sterile. Seedlings from selfed seed of five of these variants show the occurrence of similar morphological varieties in the second generation from X-rayed sex cells. Over 500 other seedlings have been obtained, some from selfed seed of X-rayed buds, some from X-rayed male and untreated female. These plants are not yet flowering, but have habit and leaf variation similar to the above. It is therefore only necessary to expose the male sex cells to X-rays to obtain an extensive series of variations. Fifteen variant plants have been cytologically examined. In about 50 p.c. there are 24 bivalents and meiosis is normal. All kinds of cytological abnormalities are present in the remainder, both in somatic and meiotic divisions. In three variants, at both heterotypic and homotypic metaphase, one univalent of one pair possesses a satellite attached by a delicate thread: 21 or 22 normal bivalents are associated with such a pair. Other variants show the following chromosome numbers:—23 bivalents + 2 univalents, 23 bivalents + 1 univalent, 22 bivalents + 2 univalents. Treatment with X-rays has also been given to sex cells of *N. rustica* var. *pumila* and *N. Bigelovii* var. *Wallacei*. Populations grown from these show little or no evidence of variation nor of reduced fertility. X-rays usually cause death of the gametes or zygotes of *N. suaveolens* and *N. nudicaulis*. J. L.

Chromosome Shape in Matthiola.—M. M. LESLEY and H. B. FROST, ("Mendelian Inheritance of Chromosome Shape in Matthiola," *Genetics*, 1927, 12) 449–60). The Snowflake variety of *Matthiola incana* R. Br. differs from other races in having extremely elongated chromosomes ($N=7$) at the late prophase and heterotypic metaphase in the pollen mother-cells. In the later stages this difference in shape is not well marked. The F_1 hybrids of Snowflake and short-chromosome varieties show the long chromosome condition to be recessive. In F_2 it reappears in about one-fourth of the progeny. The Snowflake variety produces eight distinct kinds of mutants. These do not breed true, part of their progeny always being normal Snowflake. The mutant forms are cytologically determined to be trisomic with elongated chromosomes. In three of these forms the extra chromosome is clearly a fragment of a normal chromosome. In the short-chromosome races reduction division and tetrad formation occur with no irregularities. This is also true of the F_1 hybrids between long and short, and of the F_2 plants with short chromosomes. The long-chromosome race and the F_2 segregants with long chromosomes show frequent meiotic irregularities such as non-disjunction, fragmentation, formation of dyads, triads and microcytes. Three genes for colour characters which exhibit typical Mendelian behaviour in hybrids, give evidence of recombination with the genes for chromosome shape. J. L.

Perfect Flowers in Populus.—E. W. ERLANSON and F. J. HERMANN ("The Morphology and Cytology of Perfect Flowers in *Populus tremuloides* Michx," *Papers Michigan Acad. Science, Arts and Letters*, 1927, 8, 97–110). On the hermaphrodite tree about 1 p.c. of the flowers are entirely male and about 17 p.c. entirely female. The sex organs of the perfect flowers are of normal structure and produce fertile gametes. Normal embryos are formed on self-fertilisation, but no fertilisation results from crossing female flowers of a dioecious plant of *P. tremuloides* with pollen of the hermaphrodite specimen. The spherical pollen grains of the perfect

flowers show great variation in size, their average size being larger than that in the dioecious male form. The haploid chromosome number in the dioecious male form is 19. In metaphase of the heterotypic division the chromosome group consists of one unequal sized sex pair and 18 autosome pairs of varying sizes. No irregularities are observed in the reduction division, and normal tetrads of pollen grains are formed. In both pollen- and megaspore-mother-cells of the perfect plant the haploid chromosome number is 19. Morphologically these chromosomes exactly resemble those of the pollen mother-cells of the dioecious form. The study of the chromosomes is rendered difficult by the presence of dark-staining bodies (resembling the smallest autosomes) in the cytoplasm. The chief difference between the sex pair of the perfect and male flowers appears to be the reluctance of the X and Y chromosomes of the perfect flowers to part at heterotypic anaphase. Separation may occur normally, or the entire pair may be present at one of the spindle poles. Irregularities also occur in the distribution of the autosomes of the perfect flowers, and give rise to interkinetic nuclei showing variation in chromosome number from 7 to 21. The homotypic division frequently results in polyspory with considerable range in size amongst the pollen grains.

J. L.

Chromosomes of a Triploid Tomato.—M. M. LESLEY ("Maturation in Diploid and Triploid Tomatoes," *Genetics*, 1926, 11, 267-79). The haploid number of chromosomes for the tomato is 12. In the diploid tomato there is a true spireme and typical parasynaptic pairing of threads which precedes synizesis. The meiotic divisions occur regularly and the chromosomes show no characteristic differences in size or form. The triploid form occurred as a giant plant in a culture of 90 normal ones, and has been maintained by cuttings. It shows a post-synaptic spireme consisting of a series of alternating paired and unpaired threads. The paired threads correspond to the parasynaptically paired strands of the diploid. In no case was parasynaptic union of the three threads observed. Each paired portion of spireme accompanied by an adjacent unpaired strand undergoes condensation and ultimately becomes a trisome of diakinesis. Twelve such trisomes are present, the univalent chromosomes showing different methods of attachment to one another. Occasionally univalents are seen lying free at late prophase. Random distribution of the chromosomes takes place, resulting either in polyspory or tetrad formation. The pollen of the triploid form is apparently completely sterile, but a few viable ovules have been produced.

J. L.

Effect of High Temperature on Reduction Divisions.—FUMI TAKAGI ("The Influence of the Higher Temperature on the Reduction Division of the Pollen Mother-Cells of *Lychnis Sieboldii* van Houtte," *Science Reports, Tôhoku Imp. Univ.*, 1928, 3, 461-66). The usual atmospheric temperature in the district in which the experiments were carried out varies from 29.2° C. to 5.4° C. Under these conditions reduction division in the pollen mother cells of *Lychnis Sieboldii* proceeds normally, the haploid chromosome number being 12. Under these conditions abnormalities may occur in wall formation, resulting in the production of 1-, 2-, 3- or 4-nucleate grains. Plants kept in a thermostat at 38°-39° C. for 3½ hours show abnormalities in reduction division which fall into three groups:—(1) No formation of gemini, but 24 univalent chromosomes lie scattered in the cytoplasm. Diads are formed instead of tetrads, each diad nucleus having the diploid chromosome number. The highest number of chromosomes figured in such a diad nucleus is 22. (2) Twenty-four univalent chromosomes appear and are distributed unequally. A tetrad is formed of two larger and two smaller

nuclei. (3) Each univalent chromosome undergoes a longitudinal split in prophase. The chromosomes are irregularly distributed and a number of grains varying from one to four produced. Abnormalities (1) and (2) occur in the same anther, but not in association with (3). Grains of different sizes are capable of germination. Treatment of plants at 40°-42° C. proved too drastic and brought about clumping of the chromosomes into an irregular mass. J. L.

Micro-dissection of Plant Protoplasm.—G. W. SCARTH ("The Structural Organisation of Plant Protoplasm in the Light of Micrurgy," *Protoplasma*, 1927, 11, 189-205). The impression of fluidity of the cytoplasm which one obtains from mere microscopic observation is illusory. Cytoplasm has the property of elasticity and a certain rigidity of form. This points inevitably to the existence of a permanent skeleton structure of organised and probably orientated elements. When "streaming," only a portion of the cytoplasm is ever in motion. In the resting nucleus there is evidence of an elementary structure together with a fluid sap. This heterogeneous appearance ranges from a delicate structure permeating a liquid medium to a conspicuous gelatinous framework. These observations are contrary to those made by Chambers on interkinetic metazoan nuclei, which possess no visible structure. In plant cells a persistent framework exists which might account for the genetic continuity of the chromosomes. There are two nuclear membranes, one bounding the inner surface of the cytoplasm, the other the outer surface of the nucleus. Together with the immobile gelatinous matrix of the cell, the most important element in its organisation is the active "kinoplasm." Its rôle in protoplasmic "streaming," vacuole and fibril formation is considered. The cells studied are those of *Spirogyra maxima* and other species, the fruit of *Symphoricarpos*, the leaf of *Elodea*, and the staminal hairs of *Tradescantia*. J. L.

Anatomy and Histology.

Studies in Cambial Activity.—J. J. BEIJER ("Die Vermehrung der radialen Reihen im Cambium," *Recueil des Travaux botaniques néerlandais*, 1927, 24, 631-786, 1 pl., 33 figs.). Multiplication of the radial rows in the storied cambium of the root of *Herminiera elaphroxylon* is brought about by vertical radial divisions in the extended cambium initials. The radial division walls do not terminate at the apex of the typical gable-ended cells, but end always at one of the two terminal surfaces. The root cambium is not storied at the time of its origin from the primary tissue, when it is composed of elongated rectangular cells. The storied structure develops gradually, following the appearance of the radial dividing walls. Investigations of storied cambium in the families Papilionaceæ, Crucifereæ, Simarubaceæ, Malvaceæ, Gentianaceæ and Compositæ confirm the conclusion that the conditions obtaining in the root of *Herminiera* hold true for storied cambia generally, but owing to slight intracambial apical growth the form of the cells, and consequently the whole structure of the cambium, is often somewhat irregular. Multiplication of the radial rows in the non-storied, relatively short-celled root cambium of a species of *Alstonia* is brought about by the development of more or less radially placed dividing walls, but owing to subsequent intracambial growth in length considerable rearrangement of the cells takes place so that storied structure is not developed. Enlargement of the cambial ring is generally accomplished by growth in length and breadth of the cambium initials. As the growth of these is limited, dividing walls are formed here and there. When growth in length is the more pronounced, transverse walls are formed; when growth is greater in the horizontal plane, the walls are more or less radial. When growth in the

horizontal plane, accompanied by radial division of the cambium initials, takes place, there is a possibility of storied structure being developed also. This is dependent on several factors. Development of regular storied structure is favoured by, among other things, absence of intracambial growth in length, rapid growth in thickness, very small pith and relatively long cambium initials. In the storied cambium of the root of *Herminiera elaphroxylon* most of the rays arise from the development of cross walls in the elongated initial cells. Each ray is the product of a single initial cell, so the rays so formed do not interfere with the storied arrangement of the vertical elements. The very large rays in the root of the same species arise from several adjacent initial cells, disposed one above the other, which, by transverse and oblique divisions, form the ray initials. The rays so formed are more than one storey high. In the non-storied root cambium of the species of *Alstonia* investigated the secondary rays arise from the development of transverse divisions in an elongated initial cell or a part of such a cell. In the latter case the remaining part of the initial cell may be cut off from the ray by the intracambial growth in length of the adjacent initials. The large primary rays are similarly divided up into smaller rays.

B. J. R.

Long-Lived Cells.—D. T. MACDOUGAL and J. T. BROWN ("Living Cells Two and a Half Centuries Old," *Science*, 1928, 67, 447-8, 2 figs.). The existence of a living cell in woody layers fifty or sixty years old may be taken as an example of a protoplast which has carried on an individual existence for that length of time. Sections of the desert tree *Parkinsonia microphylla*, 75 years old, showed occasional living cells near the centre. In an older trunk, estimated to be between 275 and 300 years old, living ray cells and tracheids in sections near the centre could be demonstrated without staining and with a dry objective. The stele consists almost entirely of sapwood. In some cases a small central core of heart-wood is present. Tracheids compose the greater part of the xylem. Living tracheids were numerous even in the oldest part of the stem. Nuclei in both ray cells and tracheids were large, well rounded, and clearly showed a reticulum; one to three nucleoli were present. The protoplasmic strands connecting neighbouring cells are well defined and numerous. The coenocytic arrangement of the living cells is so marked as to suggest that the connections afforded by the protoplasmic threads may be important as means of communication between the deeply lying old protoplasts and the surface layers.

B. J. R.

Micellar Structure of Tension Wood and Compression Wood.—P. JACCARD and A. FREY ("Einfluss von mechanischen Beanspruchungen auf die Micellarstruktur, Verholzung und Lebensdauer der Zug- und Druckholz-elemente beim Dickenwachstum der Bäume," *Jahrb. f. Wiss. Botanik*, 1928, 68, 844-66, 1 pl., 8 figs.). The anatomical and microchemical differences between tracheids of tension wood (*Zugholz*) and compression wood (*Druckholz*) are believed to be due to differences in micellar structure. The intention was to investigate whether the steeper inclination of the micellar spirals in tension wood was attributable to mechanical influences. The species selected were *Pinus nigra*, *Pseudotsuga Douglasii*, *Picea excelsa* and *Populus nigra*. The inclination, i.e. the angle made by the tangent to the spiral with the horizontal, was measured on radial sections under the microscope. The average measurements with the probable error are given in tabular form. Compression wood tracheids of all conifers are characterised by distinct spirals which correspond with the direction of the micellar series as indicated by the angle of extinction under polarised light. In tension wood tracheids the spirals themselves can only be demonstrated under

polarised light. The steeper inclination of the micellar spirals in tension wood as compared with compression wood is believed to account for the fact that tension wood tracheids swell and shrink less than compression wood tracheids. Fibres swell nine to fifteen times more in a direction perpendicular to the plane of the micellar series than in a direction parallel thereto. A six-year-old tree of Douglas fir, which, when four years old, had been tied down in an inclined position, provided material for the comparison of tension and compression wood with normal wood. There is a resemblance between normal summer wood and tension wood on the one hand and normal spring wood and compression wood on the other. In the case of the former, development is slower and more protracted; sliding growth is greater, with the result that these elements are longer and have steeper micellar spirals than those of spring wood and compression wood. It is concluded that the flatter micellar spiral of compression wood is due to the shorter extension of the initial cells, so that the spirals are not stretched so much as in the more extended tension wood initials. The slope of the spiral thickenings on the walls of Douglas fir tracheids is independent of the slope of the micellar spirals. Examination of a slow-grown and a rapid-grown specimen of spruce confirms the theory that rate of growth is the dominating factor in determining the inclination of the micellar spiral. Tracheids in slow-grown wood have a steeper spiral than those in rapid-grown wood. Lignification appears to be hastened in water-conducting cells. The fibres of dicotyledons are comparable to coniferous summer wood tracheids in that they do not conduct water. Their life and development are more protracted than in the spring wood tracheids of conifers. There appears to be a connection between the period at which lignification takes place and the micellar structure of the cell wall. In tension wood, which is compared to summer wood, the secondary layer is of cellulose or hemicellulose. In compression wood, on the other hand, compared to spring wood, lignification is generally complete.

B. J. R.

The Growing Point of *Hypericum uralum*.—W. A. ZIMMERMANN ("Histologische Studien am Vegetationspunkt von *Hypericum uralum*," *Jahrb. f. wiss. Botanik*, 1928, 68, 289–344, 11 pls., 5 figs.). The structure and development of the growing point are described and the successive stages in development illustrated. The vegetative cone consists of four tunicated layers and an undifferentiated central mass of tissue. The leaf develops from the first three layers. About half of the median vascular bundle is formed from the third layer; the remaining tissues, except the epidermis, arise from the second layer. Three layers take part in the formation of the axillary shoot; the third or innermost undergoes periclinal divisions, giving rise to the third and fourth layers.

B. J. R.

Pleistocene Remains of Woody Plants.—FREDERICK H. FROST ("The Pleistocene Flora of Rancho La Brea," *Univ. of California Publications in Botany*, 1927, 14, 73–98, 5 pls.). The flora of the asphalt pits at Rancho La Brea, Los Angeles, consists chiefly of wood, with occasional leaves, cones and seeds. The remains represent plants which grew round the edges of pools and were caught in the oil seeps as these extended and enlarged. The number of species is small, but the material is excellently preserved as a result of its impregnation with oil. The wood was prepared for examination by being immersed in gasoline for several months and then washed in xylol and softened in diaphanol. Sections were cut in the usual way and cleared in Eau de Javelle, after which the evidence of microscopic examination and staining reactions showed that no alterations had occurred

in the chemical and physical composition of the cell walls. The leaves and seeds were prepared by being soaked in gasoline and then dried. Five out of the seven plants described are referred to living species: *Pinus tuberculata* Gord., *Cupressus macrocarpa* Hartweg, *Quercus agrifolia* Née, *Celtis mississippiensis* Bosc. var. *reticulata* Sarg. and *Sambucus glauca* Nutt. The remains of a *Juniperus* are considered to belong to a new variety, *J. californica* Carr. var. *breaensis*, intermediate between *J. californica* Carr. and *J. utahensis* Lemm., and possibly represent a form ancestral to these two species. A fragment of a stem is provisionally referred to the Compositæ. The plant evidence suggests that the climate of Rancho La Brea in Pleistocene times was slightly cooler than the present climate of Los Angeles, with a less marked range from the hottest to the coldest month.

B. J. R.

Wood Structure of the Magnoliaceæ.—R. P. McLAUGHLIN ("Some Woods of the Magnolia Family," *Journ. of Forestry*, 1928, 26, 665-77). The author very briefly points out certain anatomical features of the wood which conflict with the sub-division of the family into the four tribes Magnoliææ, Schizandreae, Illiciæ and Trochodendreae. Two keys, based on characters visible with a lens and with a microscope respectively, show how the woods of the different species can be identified.

B. J. R.

Wood Structure of Australian Conifers.—R. T. PATTON ("Anatomy of Australian Coniferous Timbers," *Proc. Roy. Soc. Victoria*, 1927, 40, 1-16, 2 figs., 5 pls.). This article is based on the examination of specimens of all the Australian conifers with the exception of three species of *Callitris*, one species of *Actinostrobus* and one species of *Podocarpus*. The wood structure of each genus is described and the distinctive features of the various species are mentioned with reference to the generic description. In microscopic sections *Dacrydium Franklini* Hook. cannot be satisfactorily distinguished from *Phyllocladus rhomboidalis* Rich. The author considers that Baker's and Smith's separation of these two species on the presence of bordered pits on the tangential walls of *Phyllocladus* and their absence from *Dacrydium* does not hold absolutely. *Agathis* and *Araucaria* are quite distinct botanically, but microscopically the timbers are very similar. It has been found impossible to discover a single character that will separate the two genera. The wood of *Actinostrobus* is structurally indistinguishable from the closely allied genus *Callitris*. Attention is drawn to an error in Kanehira's "Anatomical Characters and Identification of the Important Woods of the Japanese Empire." His figures of *Pherosphaera Hookeriana* and *Fitzroya Archeri* appear to have been interchanged.

B. J. R.

Wood Structure of the Kauri Pines.—M. B. WELCH ("The Wood Structure of Some Species of Kauri (*Agathis* Spp.)," *Journ. & Proc. Roy. Soc. N.S.W.*, 1927, 61, 248-66, 5 figs.). This investigation was undertaken in order to determine whether any reliable method could be found to identify the woods of several species of kauri pine in commercial use. The species described are the Queensland kauris, *Agathis robusta* Masters, *A. Palmerstoni* F. v. M. and *A. microstachya* Bailey and White, Noumean kauri, *A. lanceolata* Pancher, Vanikoro kauri, *A. macrophylla* Masters, and the New Zealand kauri, *A. australis* Salisb. Microscopically *A. australis* appears to differ in the almost simple pits present in the ray parenchyma cells, the nearest approach to this being in *A. robusta*. Ray-tracheid semi-bordered pits are prominent in *A. lanceolata*, *A. microstachya* and *A. Palmerstoni*. Tracheid plugs were almost absent in the material examined of *A. Palmerstoni* and *A. microstachya* and were especially prominent in *A. lanceolata*,

A. robusta, *A. australis* and, to a lesser degree, in *A. macrophylla*. The maximum tracheid length was found in *A. lanceolata* and in *A. microstachya*, the measurement being in the vicinity of 9 mm. The rays are normally uniseriate, the greatest development of biseriate rays occurring in *A. macrophylla*, whilst no biseriate rays were found in *A. australis*. The largest rays were found in *A. lanceolata* and *A. microstachya*, being up to about 40 cells in height, and the smallest in *A. Palmerstoni* with 20 cells. The contents of the ray cells consist largely of insoluble phlobaphenes, though numerous starch grains are also present, even in the heart-wood. Resinous or oily substances occur in some species. B. J. R.

A New Maceration Method for Woody Tissues.—W. M. HARLOW ("A Chlorination Method for Macerating Woody Tissues," *Bot. Gaz.*, 1928, 85, 226-7, 1 fig.). The application of a reaction commonly employed in the preparation of wood cellulose is claimed to be superior to the maceration methods in use among plant anatomists. The method is as follows: (1) split the material into match-stick size; (2) boil to expel air; (3) immerse in strong chlorine water for two hours; (4) wash; (5) immerse in hot 3 p.c. sodium sulphite solution for 15 minutes; (6) wash; (7) repeat the process from No. 3 until, upon mild shaking, sufficient material separates for the purpose in view. When the red colour first obtained on the addition of the sodium sulphite fails to reappear in this reagent after several chlorinations, the wood should be completely delignified. B. J. R.

Morphology.

Sexual Phenomena in Plants.—J. H. SCHAFFNER ("Extraordinary Sexual Phenomena in Plants," *Bull. Torr. Club*, 1927, 54, 619-29). A *résumé* of some of the peculiarities of certain types of sexual reproduction with the object of showing the nature of sex. The *Oedogoniaceæ* exhibit a series of unusual sexual developments from a single haploid spore without any change in the chromosome complement. The same balance of genes produces every kind of sex-reaction known. Reproduction phenomena in the fungi seem to indicate that the conjugate condition has been brought about by "a mutative change which interfered with the complete primary sexualisation, for the time being, of the gametes." Three general types of sexual states have been recognised—the secondary, the partial primary, and the complete primary. The partial primary sexual state includes those cases where there is attraction but no fusion, and where there is fusion of the cells but not fusion of the nuclei. Such partial states appear to be a prolific source of chromosome disturbance and hereditary irregularities. When the secondary sexual state becomes hereditary sexual dimorphism is produced. Fusion of nuclei may bring about either a neutral condition or a secondary male or female state. In all homosporous species and in heterosporous species which are not dioecious, fusion of the gametes ends in a definitely neutral vegetative state. Sex-reversal appears to be rather common in unisexual gametophytes. Certain gymnosperms, e.g. *Picea* and *Pinus*, furnish examples of reversal when a sister-cell of the egg assumes a primary male condition. The angiosperms exhibit the most remarkable instances of triple and multiple fusions, which have no parallel in either the plant or animal kingdom; in *Sagittaria* and *Alisma* one or other of the polar nuclei assumes the male condition, and such a reversal appears to be comparable to the condition in *Spirogyra*, where one part of a filament may be male and the rest female towards an adjacent filament. More remarkable still are the multiple fusions of cells of the embryo-sacs in such genera as *Peperomia*, *Gunnera*, etc. The writer is of the opinion that such abnormal phenomena as

those cited may have a fundamental bearing on the problem of sex, and should be carefully studied, while he discredits recent genetic speculations as a hindrance to even the simplest and easiest experiments on sex-control and sex-reversal.

S. G.

CRYPTOGAMS.

Pteridophyta.

Lycopodium Sporeling.—EARLE AUGUSTUS SPESSARD ("Anatomy of *Lycopodium Sporeling*," *Bot. Gaz.*, 1928, 85, 323-33, 2 pls, 9 figs.). The stele of the sporeling of *Lycopodium lucidulum* is a protostele which is never solid; its elements may be concentric or collateral. The endodermis is not defined; the phloem appears to be at first radial and less definite later. The xylem, radially arranged at first, later forms crescentic slabs or a complete ring. The xylem is developed independently in root, leaf and stem, and later these are joined; there is no splitting or fusion of xylem. Gaps in the xylem are regarded as due, not to an invasion of cortex, but to an arrest in early ontogeny and a diversion to a different function; and the same as regards the pith. Cortex and stele are differentiated almost back at the initial stage. The phyllotaxy varies with individuals, and appears to determine the form of the stem xylem. The adventitious roots appear acropetally, and pass down through the cortex, emerging near the foot. There is an adequate conducting apparatus from the stele of the sporeling to the fungus region of the prothallium.

A. G.

Bryophyta.

New Indian Mosses.—R. POTIER DE LA VARDE ("Musci Novi Indici" *Annales de Cryptogamie exotique*," *Paris*, 1928, 1, 37-47, 4 pls.). An account of some new mosses collected in Southern India by Père Foreau, and described for the most part jointly by H. N. Dixon and R. Potier de la Varde. A new genus, *Trigonodictyon*, with one species, *T. indicum*, is defined, figured and discussed. It is referred with doubt to the Orthotrichaceæ, and is remarkable for the triangular area of hyaline cells at the base of the leaf on each side of the costa, and recalling the cancelline cells found similarly situated in the leaves of *Calymperes*. A. G.

Sporophyte of Anthocerotaceæ.—EMILY M. BARTLETT ("A Comparative Study of the Development of the Sporophyte in the Anthocerotaceæ, with Especial Reference to the Genus *Anthoceros*," *Annals of Botany*, 1928, 42, 409-30, 1 pl., 9 figs.). A comparative investigation of the development of several species of *Anthoceros*, *Notothylas*, *Dendroceros*, *Megaceros*. The conclusions drawn from the study are as follows. There is considerable variation in form and structure in *Anthoceros*. This genus is composed of two natural groups, the black-spored and the yellow-spored species, which differ in both sporophytic and gametophytic characters. A subdivision of the yellow-spored group is very closely related to *Megaceros* and to *Notothylas*. The sporogenous layer is the most constant structure of the capsule. The chloroplast in the Anthocerotaceæ is a constant structure which has some diagnostic importance. The number occurring in a cell, if more than one, is greater in the sporophyte than in the gametophyte.

A. G.

Thallophyta.

Algæ.

Myxophyceæ from China.—NATHANIEL LYON GARDNER ("On a Collection of Myxophyceæ from Fukien Province, China," *Univ. of California Publ. in Botany*, 1927, 14, 1-20, 5 pls.). An account of the blue-green algæ in a collection made

by H. H. Chung in the province of Fukien, China, in which 19 genera, 56 species and varieties were detected. Among these, 13 species and 5 varieties are described as new to science. A. G.

Soil Algæ.—B. MURIEL BRISTOL ROACH ("On the Influence of Light and of Glucose on the Growth of a Soil Alga," *Annals of Botany*, 1928, 42, 317-45, 9 figs.). An investigation of the nutrition of *Scenedesmus costulatus* Chod. var. *chlorelloides* in light and in darkness. The alga when grown in liquid cultures in a strong light is purely photosynthetic, notwithstanding the presence of glucose in the medium. As the light diminishes and photosynthesis is restrained, the alga absorbs glucose in increasing amounts to make up for the deficiency. In the absence of glucose the rate of growth is proportional to the light intensity within certain recorded maximum and minimum limits. The bearing of this upon soil fertility is as follows. When growing in the lower layers of the soil, the alga lives at the expense of such organic compounds as are available in the soil; whereas, when growing on the surface of the land, it lives photosynthetically if light intensity and moisture are adequate. In the latter case it adds organic substance to the soil, while in the former it subtracts it. The alga is typical in its behaviour of a large group of soil algæ; but there are other genera which are more vigorously saprophytic. A. G.

Desmids.—BENJAMIN MILLARD GRIFFITHS ("On Desmid Plankton," *New Phytologist*, 1928, 27, 98-107). A discussion of the origin of desmid plankton. The normal habitat of desmids is terraqueous—that is, in the wet vegetation of bogs. But there is a class of desmids which lead a plankton life, and may be divided into two groups, the benthoplanktonic or littoral desmids of weedy lakes, and the limnoplanktonic of large clear lakes where weeds are scanty. The author discusses the nature of the environment requisite to these groups, and analyses the evidence afforded by the investigations of three reservoirs. He shows that a desmid plankton may arise *de novo* whenever any body of water accumulates in a region which already possesses a desmid flora in its moist and boggy areas, and he explains that the desmid plankton is simply a selection of various forms which are inconspicuous in the terraqueous habitat, but which, when washed into the lake, thrive in the relatively poverty-stricken conditions of the open water, where the normal bog desmids cannot thrive. A. G.

Bulbochæte.—L. H. TIFFANY ("The Algal genus *Bulbochæte*," *Trans. Amer. Micr. Soc.*, 1928, 47, 121-77, 10 pls.). A monograph of the genus *Bulbochæte*, founded upon all available material, and yielding a total of 51 species, 15 varieties and 7 forms. Descriptions and measurements of each species, etc., are given, and 99 figures and a key are provided. In the introduction is a short account of the cell structure and reproduction. There is also an alphabetical summary-table, showing the type of sexual reproduction, the ornamentation of the oospore wall, and the geographical distribution of the species, varieties and forms. A. G.

Algæ of Iowa.—L. H. TIFFANY ("The Filamentous Algæ of North-Western Iowa, with Special Reference to the Oedogoniaceæ," *Trans. Amer. Micr. Soc.*, 1926, 45, 69-132, 16 pls.). An enumeration of 200 filamentous freshwater algæ collected in north-western Iowa by Tiffany and others, with keys to the species, 179 figures, and a bibliography. *Oedogonium* is represented by 56 species, *Spirogyra* by 34. Some brief but valuable advice to collectors is given in the introduction, as to finding the material, selecting suitable fertile specimens for preservation, fruiting seasons, the value of accurate drawings. A good preservative which will keep algæ in good identifiable condition for years is that of Transeau—6 parts water, 3 parts alcohol (95 p.c.), 1 part formalin. A. G.

New American Algæ.—NATHANIEL LYON GARDNER ("New Rhodophyceæ from the Pacific Coast of North America, IV and V," *Univ. of California Publ. in Botany*, 1927, 13, 373-402, 403-34, 21 pls.). Descriptions and figures of new species of *Antithamnion*, *Callithamnion* and *Pleonosporium* from California, with critical notes on their affinity. In all, 21 species and 2 varieties are described.

A. G.

Free-growing Fucoids.—GLADYS L. NAYLOR ("Some Observations on Free-Growing Fucoids," *New Phytologist*, 1928, 27, 61-68, 4 figs.). A description of *Fucus serratus* megecad *limicola*, a hitherto undescribed form, found growing loose on muddy sand on the coast of Inverness-shire, in the sheltered Arisaig loch and the cove at Rhue Pier. The plant has a dwarf habit, reproduces vegetatively, and lacks an attachment disc; the thallus is much branched and characteristically curled. It endures six hours' exposure between tides unharmed. Other unattached algæ associated with it are *Ascophyllum nodosum* var. *Mackaii* and a free form of *Pelvetia canaliculata*. The *Ascophyllum* is the most abundant of the loose-lying algæ in the district, and occurs in globular tufts up to a foot and a half in diameter. During August many specimens were noticed which showed intermediate stages between *A. nodosum* and the variety *Mackaii*.

A. G.

Free Iodine from Laminaria.—PIERRE DANGEARD ("Sur les conditions du dégagement de l'iode libre chez les Laminaires," *Comptes Rendus Acad. Sci. Paris*, 1928, 186, 1371-3). Several Laminariæ and Fucaceæ liberate iodine during life, and will turn starch-paper blue, even when not absolutely in contact with it, the iodine being volatile. Some experiments upon *Laminaria flexicaulis* are described. The stem, if cut across, leaves a print of its periphery on starch-paper. A linear incision in the cortex stimulates the iodine-liberation from the cells adjacent to the cut. If a tangential slice is removed, it is the cells surrounding the wound that yield a blue print. By the application of acid or strong alcohol, the cortical cells are made to react in the same way. During slow desiccation of the alga, iodine is exhaled for some days; there is thus a considerable loss of iodine in algæ cast up on the shore.

A. G.

Fossil Calcareous Alga.—FREDK. CHAPMAN ("On a New Genus of Calcareous Algæ from the Lower Cambrian (?), West of Wootana, South Australia," *Trans. Proc. R. Soc. South Australia*, 1927, 51, 123-25, 1 pl.). A description and discussion of *Mawsonella wootanensis*, a new genus and species of fossil calcareous alga found by Sir Douglas Mawson in the limestones of South Australia. It consists of a mass of thick-jointed segments averaging about 3×1.5 mm., which show no differentiation into an external and an internal layer of cells, such as is found in *Sphaerocodium*. The cellular structure is very minute, and in some parts the cells dichotomise after the manner of *Epiphyton*. The joints were attached to one another by short filamentous connections.

A. G.

Fungi.

Phycomycetes in America.—PAUL W. GRAFF ("Contribution to Our Knowledge of Western Montana Fungi. II. Phycomycetes," *Mycologia*, 1928, 20, 158-79). A previous paper on Montana fungi dealt with the Myxomycetes. The author passes under review 12 families of this second class; he considers that, as time passes, the numbers of species will be largely added to. References and habitats are given with descriptive notes.

A. L. S.

Pythium in Conifers.—E. J. ELIASON ("Comparative Virulence of Certain Strains of *Pythium* in direct Inoculation of Conifers," *Phytopathology*, 1928, 18, 361-7). The author experimented by means of cultures and inoculations with 22 species and strains of *Pythium*, and found that all but three caused damping-off in some coniferous seedlings. Other fungi were also tested: *Aphanomyces euteiches*, a parasite on roots of *Pisum sativum*, caused damping off and root-rot in a few coniferous seedlings; an *Alternaria* and a *Fusarium* gave no results of parasitism in the experiments. A. L. S.

Pythium in Hepaticæ.—G. NICOLAS ("Sur un *Pythium* parasite du *Marchantia polymorpha* L.," *Bull. Soc. Mycol. France*, 1927, 43, 119-21, 1 text-fig.). The association of fungi with Hepaticæ is a well-known phenomenon. Nicolas found the ordinary type of mycorrhizal hyphæ in the thallus of *Marchantia polymorpha*, situated in the lower tissues of the hepatic; but above these layers there was a second parasitic species with large, sparsely septate mycelium, and associated with the hyphæ both oogonia and antheridia of a *Pythium*. In all the infected cells the starch had disappeared and their walls were coloured brown-violet. The author considers that it may be a new species, *Pythium Marchantieæ*, or may, perhaps, be a new form or race of *P. de Baryanum*. A. L. S.

Formation of Zygosporos in Basidiobolus ranarum.—ZYGMUNT WÓYCICKI ("O tworzeniu się zygot u *Basidiobolus ranarum* Eidam II," *Acta Soc. Bot. Pol.*, 1927, 5, N. 1, 52-9, 1 pl.). Polish with French *résumé*. After renewed researches the author states his observations that after the passage of the male nucleus into the female cell the two nuclei fuse without preceding division. The fused nucleus at once divides and a second division follows so primitive that it recalls amitosis. Three of the resulting nuclei disappear, leaving one to become the definitive nucleus of the zygosporos. Comparison is made with zygosporos formation in *Spirogyra*, where much the same phenomena have been noted. A. L. S.

Morphology and Biology of *Mucor spinosus*.—A. SARTORY, R. SARTORY and T. MEYER ("Contribution à l'étude des caractères morphologiques et biologiques de *Mucor spinosus* Van Tiegh. (*Zygorhynchus spinosus*) cultivé sur des milieux se rapprochant de l'habitat où il a été isolé," *Comptes Rendus*, 1928, 186, 1367-71). The fungus was isolated from the digestive canal of xylophagous larvæ of *Lepidoptera* and *Cleoptera*. It was therefore decided to grow it on a culture medium resembling as nearly as possible the natural habitat. The tests were made both in aerobic and anaerobic conditions, the latter giving the best results. The culture medium was composed partly of fecal substances. In the anaerobic culture hydrolysing diastases appeared which transformed cellulose into starch. A. L. S.

New Discomycetes.—L.-J. GRELET ("Discomycetes nouveaux, 2^e série," *Bull. Soc. Mycol. France*, 1927, 42, 203-7, 1 pl.). Grelet describes ten new species or varieties of minute Discomycetes, giving full microscopic details, which are reproduced on the plate. One of those described, *Stenocybe major* var. *Macvicaris*, was sent from Inverness. *Stenocybe* is usually classified among lichens, but this variety had a curious habitat—the stalk of a hepatic, *Plagiochila punctata*. The variety is evidently a synonym of *Stenocybe major* Wats. (*Journ. Bot.*, 1928, 63, 130). A. L. S.

Study of *Parodiella*.—K. B. BOEDIJN ("Das Myzel von *Parodiella* Spegazzinii Theissen et Sydow," *Zeitschr. Pflanzenkr. und Pflanzensch.*, 1928, 38, 129-32, 4 text-figs.). Other species of *Parodiella* growing on leaves have been considered

as epiphytes; Boedijn has demonstrated that the above species is a parasite. The fungus grew in Sumatra on species of *Crotalaria*. By means of microtome sections he proved the penetration of the leaf tissue by the fungus mycelium which developed chiefly between the cuticle and the epidermis; hyphæ were also observed to penetrate the outer epidermal layer. Considerable damage is done, as the attacked leaves die off. Boedijn has classified this Pyrenomycete in the family Sphæriaceæ.

A. L. S.

Spore Discharge in *Podospora curvula* de Bary.—C. T. INGOLD (*Ann. Bot.*, 1928, 42, 567–70, 2 text-figs.). Ingold has studied the time and manner of discharge of the mature spores and also the number of spores. He found that discharge took place mainly in the day-time, and the maximum rate between 10 a.m. and 4 p.m., in this resembling other fungi of the dung flora. Discharge from a perithecium may continue for five days. Tables are given of the numbers discharged during the successive hours.

A. L. S.

Production of Fertile Hybrids in the Ascomycete *Neurospora*.—B. O. DODGE (*Journ. Agric. Research*, 1928, 36, 1–14, 4 pls.). Dodge secured his hybrid perithecia by crossing two species of the red bread-mould fungus *Neurospora sitophila* with *N. tetrasperma*, the first of these, a heterothallic form with eight spores in the ascus, the latter a homothallic species with normally four-spored asci. The crossing was secured by growing together the mycelia produced from spores of the two species. The asci of the hybrid perithecia were normally eight-spored, thus resembling *N. sitophila*. When germinated, the spores developed an abundance of conidia of the *sitophila* type. Perithecia were formed on mycelia from the different ascospores. Third generation ascocarps were also developed. Various other crossings were made, and the results are given. The *tetrasperma* type was recovered by mating first generation mycelia with the parent type; the asci contained four spores and the perithecia were morphologically identical.

A. L. S.

Nectar Yeast.—G. A. NADSON and N. A. KRASSILNIKOV ("La levure du nectar des fleurs: *Anthomyces Reukaufii* Gruess." *Bull. Soc. Mycol. France*, 1927, 43, 232–44, 2 pls.). This fungus is widespread in nature. It was obtained from the flower by the use of a capillary pipette; the nectar with the fungus was developed on nutritive media. The first formation noted was of four cells in aeroplane form, narrow at one end and thickened at the other, various changes followed, and finally ovoid or ellipsoid resting cells were formed. The germination of these cells in dilute honey, in fresh honey, or in beer-wort, is described. Other modifications arose: on gelatine-wort a mycelium was formed with conidia. The mycelium was branched verticillately. A second dwarf form was found in certain nectars differing only in the smaller dimensions. The nature of the cell was also studied: vacuoles were noted and a nucleus in each cell. The yeast did not produce fermentation, and evidently bears little relation to *Saccharomyces*.

A. L. S.

Study of *Sporobolomyces*.—A. GUILLIERMOND ("Étude cytologique et taxonomique sur les Levures du genre *Sporobolomyces*," *Bull. Soc. Mycol. France*, 1927, 43, 245–58, 1 pl., 6 text-figs.). The genus *Sporobolomyces* was established for three species of yeast-like fungi with coloured pigments that formed conidia at the end of filaments supposed to resemble basidia. Guilliermond, by means of cultures and microscopic examination, claims to have proved that the cells of *Sporobolomyces* are always uninucleate, and thus do not approximate to the

cytological character of basidia. On account of their peculiar conidia, however, they are unlike other yeasts and merit special classification. The author gave attention also to the red-coloured granulations, and found that they had no connection with the "mitochondries" of the cells.

A. L. S.

Study of *Venturia inaequalis*.—E. E. WILSON ("Studies of the Ascigerous Stage of *Venturia inaequalis* (Cke) Wint. in Relation to Certain Factors of the Environment," *Phytopathology*, 1928, 18, 375–418, 2 pls., 6 text-figs.). Wilson has studied this fungus parasitic on leaves of *Pyrus* with a view to tracing its development through the ascigerous stage—as to whether dead leaves could become infected, the relation of the leaf-fall to infection, and, finally, all the changes during the growth of the *Venturia*. No evidence was found that leaves became infected on the ground. Moisture had a very direct influence on development, as the hyphae of the subcuticular leaf layer only penetrated the internal cells when moisture was present, and the perithecia developed more rapidly on wet leaves, though continuous moisture induced certain abnormalities in the perithecia, such as the formation of vegetative tissue within the fruiting body. Alternate wetting and drying led to more normal development.

A. L. S.

Monilioid Species of *Sclerotinia*.—EDWIN E. HONEY (*Mycologia*, 1928, 20, 127–57, 3 pls., 4 text-figs.). The author has established a new genus *Monilinia* to include species (hitherto classified under *Sclerotinia*) that develop *Monilia* as the conidial stage. *Monilinia fruticola* (Wint.) Honey is designated as the type species of the new genus. This fungus causes the brown-rot of orchard fruits. The distinctive characteristics are the presence of a pseudo-sclerotium and the monilioid conidial stage. A historical account of the genus is given by the author.

A. L. S.

New *Discomycetes*.—GEORGES MALENÇON ("Quelques espèces inédites de *Discomycètes*," *Bull. Soc. Mycol. France*, 1927, 43, 95–106, 1 col. pl., 5 text-figs.). The five species described are minute plants and grew on the soil, on stalks of grass, or on pine needles. Full microscopic descriptions and figures are given throughout, and an account of the various affinities. There is in addition a coloured plate representing the new species.

A. L. S.

Culture of *Ustulina vulgaris*.—C. KILLIAN ("Observations sur *Ustulina vulgaris* Tul. cultivé en milieux artificiels," *Bull. Soc. Mycol. France*, 1927, 43, 35–40, 2 pls.). *Ustulina* is a widely spread species that after the spring rains presents a massive brown crust covered by a layer of grey conidia. Experiments in culture were made with various media, but mycelium and conidia only were produced. It was found that the fungus grew almost equally well on a great variety of substances, and it was noted that it always formed excavations in the substratum. This was found to be due to extraction of water by the fungus. *Ustulina* is hygrophilous rather than xylophagous, and secures water from the decaying timber on which it grows.

A. L. S.

Study of *Aspergilli*.—K. B. BOEDIJN ("Notes on Some *Aspergilli* from Sumatra," *Ann. Mycol.*, 1928, 26, 69–84, 10 text-figs.). The author found that the species with which he was working were easily arranged in big groups, and it is under the group name that he has described them. In some cases one form, in others several are recorded. In discussing characters he finds that mycelium and pedicel are indistinguishable. The stalk of the conidiophore may, however, be either pitted or smooth; the head vesicle and the sterigmata differ considerably, and there may be both primary and secondary sterigmata. He considers that

cytological studies yet to be undertaken may be important in classification. Many of the so-called species may possibly have arisen as mutants; "nearly every classical species falls into a fairly large number of smaller forms or races. The species should be based," he concludes, "on distinct, constant morphological characteristics only." A. L. S.

Study of Phyllachora.—C. KILLIAN ("Le Phyllachora Podagrariæ (Roth) Karst., parasite de l'Aegopodium Podagrariæ L.," *Bull. Soc. Mycol. France*, 1927, 43, 41–8, 2 pls.). The black leaf spots caused by the parasite appear on the living plants, the fungus continues to subsist during the winter on the dead leaves. Killian has undertaken a study of the hibernating stage. He failed to form cultures from the dead leaves; he was more successful with pycnospores taken from the living host. He has described the course of attacks in spring and the formation of winter pycnidia in the dead leaves from an internal stroma. It has been stated that the perfect form of this fungus is a *Mycosphærella*, but Killian was unable to verify that. A. L. S.

Study of Rust on Oats.—MABEL L. RUTTLE and W. P. FRASER ("A Cytological Study of Puccinia coronata Corda on Banner and Cowra 35 Oats," *Univ. Calif. Publ. Botany*, Berkeley, California, 1927, 14, 22–72, 9 pls.). The authors explain that the work was undertaken to throw light on the nature of resistance and susceptibility. In the introduction there is a historical account of the crown rust of oats. The infection of the host by the hyphæ of the germinating spores is described in detail. After entrance by appressoria numerous haustoria are formed, by which contact is ensured between the fungus and the internal cells of the host. Comparison is made between the infections on Banner and on the more resistant Cowra 35. On the latter the haustoria function briefly, if at all, and are frequently killed. In infections on Banner the host tissue is stimulated by the presence of the fungus, and in reproduction many hyphæ at the centre of infection grow towards the surface and fork beneath the epidermis, developing a dense web of mycelium from which spores and stalks are formed. A. L. S.

Puccinia Sorghi.—E. C. STAKMAN, J. J. CHRISTENSEN, and H. E. BREWBAKER ("Physiologic Specialization in Puccinia Sorghi," *Phytopathology*, 1928, 18, 345–54). The authors state that the best method of reducing losses from certain corn diseases is the development of disease-resistance lines. They find that there are various physiologic forms of corn smut, *Ustilago Zeæ* as well as of *Puccinia Sorghi*. They discuss the production of selfed lines of corn and their reaction to smut and rust: all combinations of resistance and susceptibility appear in the field. It is important, in producing new varieties of crop plants, to determine their reaction to physiologic forms of the most important disease fungi and to realise that new varieties or lines may be more susceptible to hitherto unimportant pathogenes than the varieties now commonly grown. A. L. S.

Japanese Uredinæ.—NAOHIDE HIRATSUKA ("A Contribution to the Knowledge of the Melampsoracæ of Hokkaido," *Jap. Journ. Bot.*, 1927, 3, 289–322). The writer has used as material for his study collections made in 1896 by Dr. Naoharu Hiratsuka, by M. Miura in 1913 (determined by Sydow), and others. He himself has collected and studied the group for some time. He records 58 species in 13 genera. Several species are new to Japan, and *Chnoospora Itôana* and *Phakopsora Artemisæ* are new to science. The author gives full references, localities, and occasional biological notes. A host index completes the paper. A. L. S.

Rusts on Trillium.—M. F. BAREUS (*Mycologia*, 1928, 20, 117-26, 2 pls.). This rust was first described as *Aecidium Trillii*. It has been thoroughly examined by the author and many inoculations have been made. Associated stages are *Uromyces digitatus* and *U. Halstedii*. Uredospores and teleutospores were induced on *Brachyelytrum erectum*.
A. L. S.

Study of Ustilaginales.—R. CIFERRI ("Quarta contribuzione allo studio degli Ustilaginales (Nos. 55-126)," *Ann. Mycol.*, 1928, 26, 1-68, 1 pl.). The previous papers on this subject were published in other journals. The present important contribution deals with many genera from Europe and other countries, including the Dominica Republic. The first notice deals with the genus *Endothlaspis* Sorokine, the two species of which, he holds, belong to *Sphacelotheca*. The two families Ustilaginaceæ and Tilletiaceæ are examined, some of the genera, e.g. *Entyloma*, in great detail. Special attention is given to the organs of the host plants that are attacked, as thus the fungal characters are aids to determination.
A. L. S.

Study of Coprinus.—W. F. HANNA ("Sexual Stability in Monosporous Mycelia of *Coprinus lagopus*," *Ann. Bot.* 1928, 42, 379-89). This paper takes up the question as to the development of the monosporous mycelia of the heterothallic Hymenomycete, *Coprinus lagopus*. The culture of a heterothallic spore results in the formation of haploid mycelia, each cell remaining uni-nucleate. Spores of a fruit-body of *Coprinus lagopus* were cultivated on artificial media and ten successive generations of haploid fruit-bodies were grown. In time the haploid mycelia lost the power of forming the fruiting stage, but not the power of uniting sexually with another mycelium of opposite sex. The haploid fruit-bodies of *C. lagopus* had a relatively small number of spores but these were of the normal size. It is concluded that sexual mutations may occur but only rarely in this species from the haploid to the diploid condition.
A. L. S.

French Hymenomycetes.—H. BOURDOT and 'A. GALZIN ("Contribution à la flore mycologique de la France. I. Hymenomycètes," Lechevalier, Rue de Tournon 12, Paris VI^e, 1928, 1-761, 185 text-figs.). This volume has been issued under the auspices of the French Mycological Society. It deals with all the more primitive resupinate Hymenomycetes. A very large number of families and genera have been exhaustively dealt with. Analytical keys to the species are provided. There are full descriptions with a careful account of habitat and locality. The great advantage of the difficult group the authors have studied is that specimens are easily preserved for reference or examination. Advice is given as to the treatment best suited to the different types and also as to the methods of examination.
A. L. S.

Australian Basidiomycetes.—J. BURTON CLELAND ("Australian Fungi: Notes and Descriptions, No. 6," *Trans. and Proc. Roy. Soc. South Australia*, 1927, 51, 298-306). The present publication is a continuation of previous papers, and the species numbers following on those already recorded are from 455 to 482. They are all members of the Agaricaceæ belonging to five different spore groups. Most of them are new to science; all are described in detail, with notes on localities and affinities.
A. L. S.

Skepperia carpatica.—ALBERT PILAT ("Skepperia carpatica sp. n., nouvelle espèce intéressante du genre Skepperia Berk. dans les Carpathes centrales," *Bull. Soc. Mycol. France*, 1927, 43, 49-58, 1 pl.). Hitherto this genus has been found only in the tropics. A number of specimens of the new species were discovered by

Pilat on decaying trunks, but only in one locality, in the High Tatra. He draws attention to the very large cystidia of the hymenium, and compares them with those of other species. He has taken occasion to review the genus and to describe all the members. One of the species, *Skeppera spathularia*, which has no cystidia, he places in a new genus, *Skepperiella*, first described as a *Craterellus* from Ceylon, later found also in Cuba.

Savernake Forest Fungi, III.—CECIL P. HURST (*Wiltshire Arch. and Nat. Hist. Mag.*, 1926, 43, 465-76). A large and varied series of fungi are listed, with descriptive notes. Most of the species, Basidiomycetes and Ascomycetes, are of the larger types, but a number of minute Ascomycetes are also recorded.

A. L. S.

Fungi from Venezuela.—N. PATOULLARD ("Quelques Champignons du Vénézuëla," *Bull. Soc. Mycol. France*, 1927, 42, 288-94, 2 pls.). The publication of the posthumous papers of Patouillard has been taken in hand by Roger Heim. The renowned mycologist was active to nearly the end of his life, mainly with exotic plants. From Venezuela he had received a large collection, and a few of the species new to science are now published; they belong to the larger Polyporeæ.

A. L. S.

Fungi from Annam.—N. PATOULLARD ("Champignons nouveaux de l'Annam," *Bull. Soc. Mycol. France*, 1927, 43, 24-34). The fungi described in this paper were collected by M. Poilane in the mountainous forests of Annam. A large series of new species of Polyporeæ and a few other forms also new to science are recorded.

A. L. S.

Mycology of Annam and Laos.—N. PATOULLARD ("Nouvelle contribution à la flore mycologique de l'Annam et du Laos, III," *Ann. Crypt. Exotique*, 1928, 1, 2-24, 1 pl.). This work by N. Patouillard was completed before his death in 1926, and is now placed on record by Roger Heim. The species recorded were collected by M. Poilane in 1922-24. Several species and varieties or forms are new to science in Annam and Siam (Laos). The Basidiomycetes predominate, especially the tougher drier types, which retain their form. A few Ascomycetes and Hyphomycetes are also recorded.

A. L. S.

Fungi of Tonkin.—ROGER HEIM and G. MALENÇON ("Champignons du Tonkin recueillis par M. V. Demange," *Ann. Crypt. Exotique*, 1928, 1, 58-74, 2 pls., 6 text-figs.). One Mycetozon, *Arcyria cinerea*, and one Pyrenomycete, *Xylobotryum andinum*, are included. The other fungi are Basidiomycetes of various families and genera. Microscopic details are given in the text-figures. On the plates are depicted some of the rarer species—two of them new to science, *Stereum zebra* and *Arrhenia putila*. The former is described as whitish or ochraceous with concentric deep brown lines. The hymenium is salmon-coloured.

A. L. S.

Fungi from Costa Rica and Panama.—FRANK LINCOLN STEVENS (*Illinois Biological Monographs*, 1927, 11, No. 2, 1-102, 18 pls., 1 map). The fungi recorded were collected by Stevens during a stay of two months in these regions. In Costa Rica the most interesting and richest localities were primitive high forests, also various jungles and swamps. In Panama the primitive jungle lay on all sides, and fungi were abundant. The record comprises 123 species of microfungi: Meliolas, Perisporiales, Microthyreaceæ and Dothideales were especially abundant. Many of the species are new to science; new genera are *Myrianginella* (Myriangiales); *Pseudoparodiella*, *Tonduzia*, *Dimeriellopsis* and *Hyal-*

meliolina (Perisporiaceæ); *Ceratochaetopsis* (Capnodiaceæ); *Rheimiatopeletis* (Polystomellaceæ); *Scolecococcidea* (Coccoidæ); *Hyperus* (Dothideæ); *Pycnidiostroma* (Dothideales); *Scenomyces* (Tuberculariaceæ), the last-mentioned an imperfect development, loose mycelium spreading over the leaf surface with aggregations that suggest perithecia. No conidia or spores were observed. A. L. S.

Fungi from Costa Rica.—H. SYDOW ("Fungi in itinere costaricensi collecti," *Ann. Mycol.*, 1928, 26, 126–31). Sydow here gives the diagnosis of a number of microfungi in addition to those he had already described. A list is given of host-plants which had been omitted from previous contributions. A. L. S.

Novæ Fungorum Species.—XIX.—H. SYDOW (*Ann. Mycol.*, 1928, 26, 132). These new species of microfungi are from widely scattered localities—Africa, Porto Rico, Philippines, etc. Two new genera are included—*Placodothis* (Dothideaceæ) and *Ormathodium* (Hyphomycetes). Full descriptions are given of the microscopic characters. A. L. S.

Fungi Borneenses.—H. SYDOW (*Ann. Mycol.*, 1928, 26, 84–99). The fungi here enumerated were collected by A. D. E. Elmer in British North Borneo. Sydow notes that the district must be specially rich in *Meliolæ* leaf parasites, as besides the species described (mostly new), many were undeterminable from over-maturity. One new genus is recorded, *Anatexis* (Englerulacearum). A. L. S.

Chili Fungi.—H. SYDOW ("Fungi Chilenses a cl. E. Wedermann lecti, pars prima," *Ann. Mycol.*, 1928, 26, 100–26). The above contribution includes only a part of the large collection of fungi made by Wedermann during a long stay in different provinces of Chili. The list includes Uredineæ, Pyrenomycetes, Discomycetes and Sphærospideæ. The new species are described with full microscopic details; the new genera are *Leptosacca*, *Chiloëlla* (Pyrenomycetes), *Pleuroplacosphæria* (Fungi imperfecti), and *Pezomela* (Discomycetes). All those dealt with are microfungi, and the microscopic and other characters are fully described. A. L. S.

Developments of Fusicladium.—C. KILLIAN ("Le cycle évolutif du *Fusicladium depressum* Berk. et Br. et du *Fusicladium Aronici* Saco," *Bull. Soc. Mycol. France*, 1927, 43, 282–92, 4 pls.). *Fusicladium* is known as a genus of microscopic fungi parasitic on fruit trees, etc. The two species studied in this paper grew—*F. depressum* on Umbelliferae, *F. Aronici* on *Aronicum scorpioides*—on the lower surfaces of the leaves. An account is given by Killian of their microscopic characters and their effect on the host plants. In *Fusicladium depressum* the conidiophores emerge from the stomata of the leaf and bear several conidia at the apex. He proposes to place this species in the genus *Passalora*. *Fusicladium Aronici* has curved conidiophores and single large conidia, and has an associated pycnidial stage which develops from a sclerotium. Killian places it in *Fusicladiella*. The various stages are depicted on the plates. A list is given of literature cited in the text. A. L. S.

Growth of Fungi in Soil.—E. McLENNAN (*Ann. Appl. Biology*, 1928, 15, 95–109, 1 text-fig.). Various methods were used to determine the amount of fungi in soil and the condition in which the fungus was present, whether as mycelium or as spores. Sterile soil was inoculated with spores of species of *Alternaria*, *Penicillium*, *Trichoderma* and *Verticillium*. After a given time portions of the soil were plated and the colonies formed were reckoned. Cultures were also made from soil directly—moist soil and soil that had been dried. From these tests it

was concluded that fungi were present in the soil in the mycelial condition, as abundant growths were produced from moist soil, but scarcely at all from dried soil, in which spores, had they been present, would have survived the drying process.

A. L. S.

Parasitic Fungus on Cornus.—C. KILLIAN and V. N. LIKHITÉ ("A propos d'un parasite du *Cornus sanguinea* L., l'*Asteroma Corni* Desm. des auteurs," *Bull. Soc. Mycol. France*, 1927, 42, 216–25, 3 pls.). The authors have made an elaborate cultural and microscopic study of this parasite. It grows on the young twigs and petioles of the host, forming small red spots. They found that there was an external mycelium which penetrated by the stomata; the internal mycelium formed sclerotia, which produced conidia and later pycnidia of the *Mycospharella* type. Their research has led the authors to place the species in *Ramularia* rather than in *Asteroma*. The microscopic details are figured on the three plates.

A. L. S.

Blight Disease of Strong-Scented Love-Grass.—YOSIKAZU NISIKADO ("Leaf Blight of *Eragrostis major* Host. caused by *Ophiobolus Kusanoi* n. sp., the Ascigerous Stage of a *Helminthosporium*," *Jap. Journ. Bot.*, 1928, 4, No. 1, 99–112, 5 pls.). The fungus attacks the leaf blades and leaf sheaths of the grass, causing them to turn brown; in severe cases of attack whole plants become dry and dead. The disease is due primarily to the attack of *Helminthosporium leucostylum*, a Hyphomycete. On the dead tissue perithecial bodies were observed side by side with the conidial fungus, and these were identified as *Ophiobolus Kusanoi* n. sp. Cultures were made of both types, and the results confirmed the relation between the two stages of the fungus.

A. L. S.

Fungus Diseases of the Gold Coast.—R. H. BUNTING ("Fungi Affecting Gramineous Plants of the Gold Coast," *Bull. N. 10 Accra, Gold Coast*, 1928, 1–51, 11 pls. (2 col.)). The parasitic fungi described were found on maize, guinea corn, bulrush, millet, rice and sugar cane. They belong to various genera of rusts, smuts, hyphomycetes and other microscopic fungi. The appearance and microscopic characters are given, and methods of control found more or less effective are described. The hosts are generally parasitised by a number of fungi, maize by ten different parasites, not all of them equally virulent. Full accounts are given of all these, and a number of undetermined species are described from uncultivated host-plants.

A. L. S.

Sugar Cane Mycorrhizæ.—R. CIFERRI ("Preliminary Observations on Sugar Cane Mycorrhizæ and Their Relationship to Root Diseases," *Phytopathology*, 1928, 18, 249–61). Ciferri found that in sugar cane 80 p.c. of rootlets are infested by a root fungus. There are two types of infection by (1) rhizoctoneous mycelium and (2) phycomycetous mycelium. Rootlets may be invaded by both types. He found it impossible to make cultures of the phycomycetous endophyte; the *Pythium* agent seems to be an obligative parasite. The rhizoctoneous endophyte was cultivated. The invasion of these endophytes tends to destroy the rootlets and gives an impulse to the formation of new rootlets. Any cause that hinders the formation of the new rootlets, such as excessive moisture or drought, state of the soil, etc., is a great disadvantage to the plant.

A. L. S.

Vegetable Pathology.—M. GARD ("Pathologie végétale—Pourridie du noyer cultivé (*Juglans regia* L.) et carbonate de chaux," *Comptes Rendus*, 1928, 186, 1373–5). Disease of cultivated nut trees is mainly due to the fungus *Armil-*

laria mellea. Gard has studied the conditions affecting the spread of the disease, and he finds that they are mainly due to the decalcification of the soil brought about by the continual use of chemical manures. Cultures were made of germinating fungus spores in various media, and where lime was present the development was very poor. The disease is found to occur very rarely in calcareous soils.

A. L. S.

Diseases of Stone Fruits.—M. BENS AUDE and G. W. KEITT ("Comparative Studies of Certain Cladosporium Diseases of Stone Fruits," *Phytopathology*, 1928, 18, 313-29). The authors have mainly confined their study to the effects of scab produced by *Cladosporium* on *Prunus americana*, *P. armeniaca*, and *P. cerasus*. In all these the host leaf is penetrated through the cuticle by closely appressed germ tubes. Cross-inoculation gave various results. The *Cladosporium* form of *P. cerasus* had a distinctly lower thermal range for germination of conidia than the others; its conidia also failed to infect the other *Prunus* hosts. They conclude that pathologically and physiologically the *Cladosporium*s studied appear to fall into two groups: (1) those from *Amygdalus persica* and *Prunus americana* and (2) that from *Prunus Cerasus*. The former (1) appeared to be identical and are referred to *Cladosporium carpophilum* Thüm. The cherry fungus is tentatively referred to *Venturia Cerasi* (synonym: *Cladosporium Cerasi*).

A. L. S.

Lichens.

Thalline Excrecences of Lichens.—M. et Mme. FERNAND MOREAU ("Les accidents homosymbiotiques de la surface des lichens," *Bull. Soc. Bot. France*, 1926, ser 5, 2, 356-76, 15 text-figs.). In their discussion of thalline outgrowths in lichens the authors distinguish as "collemal papillæ" the minute granular outgrowths in Collemaceæ. They then discuss isidial formations in other lichens which, they conclude, never pass into uncovered soredia: these latter differ in origin and formation from isidia. Finally they describe as different structures the isidia of *Parmelia tiliacea* f. *scortea*. These begin by a rising up of the upper cortex to a minute punctiform pustule; the cortex breaks and a small column emerges, the upper cell walls becoming dark in the sunlight. This isidium is simple or branched, and is termed a "scortea papilla." The same type of isidium occurs, they find, in *Parmelia saxatilis*.

A. L. S.

Witch-Broom Formation in Lichens.—E. BACHMANN ("Hexenbesenbildung bei *Cladonia amaurocraea* (Flrk) Schaer," *Hedwigia*, 1928, 68, 5-10, 6 text-figs.). Bachmann describes the effect produced by a fungal parasite on *Cladonia amaurocraea*: there was a shortening and widening of the main podetia, with a multiplication of the shorter side-branches. He illustrates the alterations in form by line drawings and by drawings of cross-sections of the parasitised lichen. The gonidial layer was found to have considerably increased, and the algæ were undamaged by the fungus. Bachmann then describes the fungus—a minute Pyrenomyces with two-celled colourless spores, determined by Keissler as *Didymella Sandstedei* n. sp. The material was collected by H. Sandstedt at Stenholm, Lapland.

A. L. S.

Lichen Biology.—R. G. WERNER ("Biologie végétale—Symbiose obligatoire ou vie indépendante des champignons de lichens," *Comptes rendus Acad. Sci.*, 1927, 184, 837-9). The reasearch here outlined was undertaken to study the hyphal development of the lichen fungus on artificial media. A number of foliose and fruticose lichens were grown. The initial development in all was similar:

the lichen spores germinated and formed a loose fungal tissue. About the third month a differential development was noted; the growth of frondose species was somewhat spread out, that of fruticose species tended to an upright form. The mycelium in each case recalled the anatomical and morphological characteristics of the parent lichen. A new character common to all of them was the budding off of conidia from the aerial hyphæ, and these germinated and formed new colonies. The fungus of the colonies at once joined up with the algæ when these were introduced from pure cultures. Sometimes the hyphæ penetrated the gonidia, without, however, seeming to cause any injury. The gelatinous substratum was liquefied by the hyphæ, proving the saprophytic nature of the lichen fungus.

A. L. S.

Research on Lichens.—R. G. WERNER ("Recherches biologiques et expérimentales sur les ascomycètes de lichens." Thèse présenté à la Faculté des Sci. Paris, Mulhouse, Braun & Cie., 1927, 1-81, 8 pls., text-figs. A to N). We have here an account of a large series of observations and cultures regarding lichens both vegetative and reproductive. In a final summary Werner gives his conclusions on the various aspects of lichen development. As to reproductive activity, he found that *Xanthoria* produced spores during the whole year, other lichens over a more restricted period. Germination of mature spores occurred one or two days after ejaculation. The subsequent growth of the hyphæ corresponded to observations already made by other workers: the mycelium grew slowly and became coloured according to the species, but in nature the thallus died if the alga were not forthcoming. All these mycelia could attack and liquefy the gelatinous medium, thus proving their saprophytic nature. In these cultures conidia are given off by the aerial hyphæ and in some species pycnidia arise. The alga also develops on gelatine as a saprophyte. As to symbiosis, in cases of culture, the fungus loses the capacity to develop along with the alga, and parasitises the algal cells when these tend to predominate. Werner has proved that the lichen fungus is capable of development in cultures, and follows the formation of the parent thallus. He experimented on nine different families. In all of these minute growths were produced resembling more or less the lichen thallus; reproductive bodies were mostly conidia given off from the aerial hyphæ. In *Xanthoria* there were no conidia, but new colonies arose from budded-off portions of the original growths. Werner made also a study of the alga. He rejects the new generic name *Trebouxia*, as proposed by Puymaly, and retains *Cystococcus* as described by Chodat. He describes the chromatophore as stellate, and multiplication of the alga by autospores or zoospores.

A. L. S.

Lichen Physiology.—RYOSI ARNO ("Contribution to the Physiology of Lichens," Japanese with English résumé (p. 330), *Bot. Mag. Tokyo*, 1925, 39, 361-80, 1 fig.). Arno discusses several points in lichen physiology:—A. The effect produced by sulphur dioxide gas (SO_2). When dissolved in water and flowing over lichen plants on trees, rocks, etc., the gas is absorbed and the plant suffers from a too high hydrogen-ion concentration. Lichens suffer from acid in water more than the higher plants. B. Power of resistance against desiccation, he found, was strong in *Parmelia praterivisa*, which survived after three months in a desiccator with water 2.3 p.c. of the dry weight. Other lichens tested absorbed water readily in a moist atmosphere and lost it as soon as the atmosphere became dry. C. Geotropism. The podetia of *Cladonia gracilis* var. *leuochroa* placed out of their perpendicular position curved upwards in a short time as compared with their slow growth.

A. L. S.

Phototropism in Cladoniæ.—F. TOBLER ("Zur Kenntniss des Phototropismus von *Cladonia podetien* und verwandten Organen," *Planta*, 1927, 3, 169–71). The author found that in young plants of *Cladonia* the podetia responded to light, but only before the formation of cup (scyphus) or head. Proof of positive phototropism was observed in *Cladonia impeza* in plants 3 to 4 cm. in height; they were distinctly influenced by all pervading light in the course of 8–10 weeks and for even a longer time. Irregularity in direction of growth is generally due to external conditions such as moisture on the arrival of external gonidia. The part played by the latter is of importance in their influence on growth; they rather hinder the phototropic reaction. The stalk of *Baeomyces* (bare of gonidia) also showed positive phototropism. A. L. S.

Parasymbiosis in Lichens.—T. SCHAECHTELIN and R. G. WERNER ("Développement et biologie de l'*Abrothallus* Smilt.," *Bull. Soc. Mycol. France*, 1927, 42, 233–43, 1 pl.). This species, which lives on other lichens, has been classified now as a fungus, now as a lichen. Zopf found that the hyphæ of the *Abrothallus* (*Buellia*) formed a symbiotic union with the gonidia of the host plant, and he coined the term "parasymbiosis" to express the condition. The two authors have taken up the question and have entirely verified Zopf's work. The mycelium of the *Abrothallus* penetrates the host tissue even to the rhizinae, but does not injure the parent plant. Pycnidia are also formed, but remain embedded in the lichen thallus. The development of the fruiting body was also followed. Several spiral hyphæ with trichogynes are associated; the latter push their way through the cortex; their further history is not given. A. L. S.

Study of Cladonia.—M. et Mme. FERNAND MOREAU ("La signification du podétium des *Cladonia*," *Bull. Soc. Mycol. France*, 1927, 42, 249–54, 4 text-figs.). The authors take up the development of the podetium of the *Cladonia*, considered by Wainio to be primarily reproductive in origin. They find in *Cladonia coccifera* and *Cl. fimbriata* that the podetium arises not from the gonidial elements, but from the hyphæ of the cortex; these travel upwards, very fine hyphæ rich in protoplasm. At a certain height they tend to widen fan-wise; the cortex grows up around the base. The whole growth they take to be purely thalline, resembling that of the papillæ in *Parmelia scorteæ*. It is, in their view, an accident of the thalline surface, and nearly related to soredial formations. A. L. S.

Phylogeny of Cladonia.—M. CHOISY ("Sur le phylétisme des ascomycètes du genre *Cladonia* (Lichens)," *Bull. Soc. Mycol. France*, 1927, 43, 267–71). Choisy challenges the decision arrived at by M. and Mme. Moreau as to the origin of the podetium. These authors concluded that the development was identical with that of the soredial papillæ in *Parmeliæ*. Choisy draws attention to the fact that in the development of the podetium the gonidia take no part; it is solely hyphal in origin. Choisy, on this hyphal basis, traces the podetium back to *Baeomyces* and *Biatora*. In working out a scheme of phylogenetic development and of classification he stresses the importance of the spermogonia. He has drawn out a polyphyletic table representing his views. A. L. S.

Fertilisation in Collema.—M. et Mme. FERNAND MOREAU ("La reproduction sexuelle chez les lichens du genre *Collema*, et la théorie de Stahl," *Comptes Rendus Acad. Sci.*, 1926, 182, 802–4). These two authors have taken up the study of *Collema* in order to examine the fruit-development with the aid of modern technique. Stahl's account of fertilisation by means of trichogyne and spermatium they find to be incorrect. The young coiled ascogonium is composed of

uninucleate cells in communication by a perforation of the dividing wall. Many ascogonia have no trichogyne, and when the organ so designated is present it rarely reaches the surface of the thallus. As the ascogonium develops, the cells become multinucleate, up to six nuclei in a cell. These cells give place to ascogonial hyphæ, finally binucleate, producing at their extremity the asci. Spermatia take no part in fertilisation, and there is throughout no resemblance or affinity with the *Florideæ*.
A. L. S.

Ascogenous Hyphæ in Lecidea.—M. CHOISY ("Sur la morphologie des hyphes ascogènes dans le genre *Lecidea*" (Lichens), *Bull. Soc. Mycol. France*, 1927, 43, 209–10, 2 text-figs.). Choisy observed in *Lecidea turgida* and in *L. lithophila* that the young asci grew in an upright direction as the terminal cell of the ascogenuous hyphæ. There were no clamp connections nor any bending-back of the tip-cell. He notes the difference in formation from those described by Moreau in *Lecidea pantherina*, etc., and suggests that it indicates a possible natural division of the genus.
A. L. S.

Study of Gyrophoraceæ.—ROGER GUY WERNER ("Etude de la famille des Gyrophoracées," *Comptes Rendus*, 1928, 186, 1367–9). The author gives a sketch of the appearance and growth of this family of lichens mostly confined to mountain districts. *Umbilicaria pustulata*, one of the best-known members, fructifies rarely in sunlight, but apothecia are formed in shaded and moist localities. The first fruiting stages are formed in the medulla in the form of minute cushions of tissue; several of these enter into one fructification, and from each emanates a trichogyne; the ascogonial tissue forces a way upward and bursts the cortex of the thallus. The spores are rarely ejected and seem never to germinate. *Gyrophora cylindrica* resembles *Umbilicaria* in its fruit development, but the spores germinate, though growth soon ceases.
A. L. S.

Spore Formation in Bilimbia.—HENRY DES ABBAYES ("Note sur le *Lecidea* (s.g. *Bilimbia*) *Corisopitensis* Picq.," *Bull. Soc. Sci. Nat. Ouest France*, 1923, 3, 74–7, 12 text-figs.). The author has followed the division of the spores in this species, and has noted the similarity to spore-division in *Graphis*. The first septation occurs in the centre of the spore when it is comparatively small, two other septations follow in each division, the end cell being the largest. The cells farthest from the centre retain the power of division. The spores may be finally 5- or 7-septate.
A. L. S.

Study of *Mycoblastus sanguinarius*.—JOS. ANDERS ("Untersuchungen über *Mycoblastus sanguinarius* (L.) Norm., *Mycol. alpinus* (Fr.) Kernst. und *Mycol. melinus* (Krph.) Hellb.," *Hedwigia*, 1928, 68, 87–92). This lichen is distinguished by the blood-red colour of the thallus below the apothecium. The spores are very large, solitary in *M. sanguinarius*. Generally two in the ascus in *M. alpinus* and *M. melinus*, the two latter recognised by Anders as varieties of *M. sanguinarius*.
A. L. S.

Occurrence of *Siphula ceratites*.—TH. ARWIDSSON ("Die Verbreitung von *Siphula ceratites* (Wg.) E. Fr. Anlässlich der Auffindung der Art in Schweden," *Bot. Not.*, 1926, 379–92, 2 maps). Arwidsson studied the distribution of this lichen while collecting in Swedish Lapland. It is a northern species recorded on the coast of West and North Scandinavia, in North America, North Asia, and in the Himalayas. It is considered by Arwidsson as being distinctly an alpine plant, and, like other alpine plants, grows also on the coast at sea-level. A list of literature containing references to the lichen is given.
A. L. S.

Lichens from Terra del Fuego.—M. CENGIA SAMBO ("Licheni della Terra del Fuoco raccolti da G. B. de Gaspari nel 1913," *Nuovo Giorn. Bot. Ital.*, 1926, 33, 86-91). Gaspari collected the lichens while studying the geology of the country. Forests of *Fagus antarctica* and *F. betuloides* yielded many of the larger frondose and fruticose species. The lichen flora is sub-polar in character owing to the cold currents from the south. *Cladonia rangiferina* and *Cl. alpestris* grew in abundance as in Arctic regions. *Usnea melazantha* and *Nephromium antarctica* were especially prominent, the latter with apothecia 5 cm. in diameter. A. L. S.

Moriolaceæ.—E. BACHMANN ("Die Moriolaceen," *Nyt Mag. Naturvidensk.*, 1926, 64, 170-228, 3 pls., 13 text-figs.). Bachmann has taken up the study of this obscure group of lichens, first described by Norman. He has found that the algal constituents belong to the Cyanophyceæ. These occur in the thallus as goniocysts—irregular bodies enclosed in a network of hyphæ—as goniocystulæ, which are not entirely enclosed, and as thalline nuclei or groups of algæ without covering hyphæ. Bachmann distinguishes two genera, *Moriola* Norm. and *Speconisca* Norm. He has deleted from the group a number of species that are fungi without algal symbionts. He retains, however, 12 of Norman's species, and has arranged them in a synoptic table. A. L. S.

Parmelia tiliacea.—GRETA SERMANDER DU RIETZ ("Parmelia tiliacea, en Kustlav och Marin inlandsrelikt i Skandinavien," *Svensk Bot. Tidskr.*, 1926, 20, 352-65, 3 text-figs.). A record is here given of the occurrence of *Parmelia tiliacea* (Hoffm.) Vain (= *P. scortea* Ach. non *P. tiliacea* Ach.). It is found along the sea-coast on moderately ornithocoprous sea-cliffs, on rocks at fishing places, and on archaic limestones round the coasts of Scandinavia. In inland localities it is to be found on stone walls, old trees, etc., and is always somewhat impregnated with dust. *P. tiliacea* seems to be moderately alcaliphilous, but not thriving on strongly alkaline habitats such as extreme sea-fowl cliffs. Records of localities are given and an index of literature. A. L. S.

New Lichen from Western Asia.—A. KNEUCKER ("Eine neue Flechte vom Sinai und vom Ufer des Toten Meeres," *Allg. Bot. Zeitschr.*, 1926, 30 (31), 43). The new species, *Psorotichia sinaiensis*, was first collected on the north-west coast of the Dead Sea, not far from Jericho, and was determined by Wainio. It has a thin yellowish thallus. A. L. S.

Lichens from Trosa.—GUST. O. A.-N. MALME ("Några Lavar från Trosatrakten," *Svensk Bot. Tidskr.* 1926, 20, 52-9). A varied series of lichens are recorded, with habitat and notes. A. L. S.

Lichens of Denmark.—H. MØLHOLM HANSEN ("Hammer Bakkev. En Botanisk Undersøgelse, ivaærksat af Dansk Botanisk Forening. v. Likenen-og Mosvegetationen," *Bot Tidsskr. Københ.*, 1926, 39, 279-88). Hansen has examined and classified the lichens of this expedition. He gives a sketch of the locality explored and a complete list of the lichens found. A. L. S.

Lichens of Croatia.—FRAN KUSAN ("Predranje za floru lišajeva Hrvatske I. Izvještaj (Vorarbeiten zu einer Flechtenflora Kroatiens. I. Mitteilung," *Acta Bot. Inst. Bot. Univ. Zagrebensis*, 1928, 3, 1-40, 1 map. With German *résumé*). The writer finds that little is known as yet of the lichens of Jugoslavia, though the neighbouring countries have been fairly well worked. As a result of the research undertaken, 163 species have been listed. A number of forms new to science were determined, with one new species, *Biatorella biformis*, characterised by the very large apothecia up to 3 mm. in width. A. L. S.

Canadian Lichens.—CARROLL W. DODGE ("Lichens of the Gaspé Peninsula, Quebec," *Rhodora*, 1926, 28, 157-207, 225-232). The writer gives a historical account of lichen collection in Eastern Quebec, and chronicles the lichens collected in the various expeditions. He himself secured a number of lichen species, though his main object was the study of Basidiomycetes. The Cladoniaceæ bulk largely in the list.

A. L. S.

Lichens of Bohemia.—V. CYPERS LANDRECY ("Beiträge zur Kryptogamenflora des Riesengebirges und seine Vorlagen," *Lotos*, 1926, 74, 1-18). The author notes that the Silesian part of the Riesengebirge has been well worked for lichens, though other districts of the mountains have been neglected. Habitats and localities are carefully described, unless in cases where the lichen is a well-known common species.

A. L. S.

Lichenological Contributions. VIII.—G. EINAR DU RIETZ ("Lichenologiska Fragment VIII. Ett Bidrag till Åsele Lappmarks Lavflora," *Svensk Bot. Tidskr.*, 1926, 20, 281-3). An account of lichens collected during a journey to Northern Sweden—Norrland—Åsele, and other localities. *Cladonia* was the most abundant in species.

A. L. S.

Lichens on Jungfrun Island.—G. EINAR DU RIETZ ("Die Hauptzüge der vegetation der Insel Jungfrun," *Svensk Bot. Tidskr.*, 1925, 19, 323-46, 7 text-figs.). Jungfrun is a small island of granite, sandstone, etc., in the Kalmarsund, near to Oland. A general account of the locality and of the ecology is given, with a special reference to lichens. A *Verrucaria maura* association or girdle occupies a position near the sea; above that, *Caloplaca marina*, *Lecanora quartzina* and others. On the upper reaches the lichen associations are the leading vegetation, and a number of associations are described.

A. L. S.

Lichen Flora of South Georgia.—G. EINAR DU RIETZ ("Zur Flechtenflora von Sudgeorgien," *Nyt Mag. Naturvidensk.*, 1926, 64, 229-33). The most important of the lichens collected was *Sticta* (*Pseudocyphellaria*) *endochrysa*, a sub-antarctic species. Another southern plant of the island, *Usnea aurantiaco-atra*, has been confused with *Usnea sulphurea*. The majority of the lichens have also been recorded from Northern Europe.

A. L. S.

Scandinavian Stereocaulons.—G. EINAR DU RIETZ ("Skandinavians Stereocaulon-arter," *Svensk Bot. Tidskr.*, 1926, 20, 95-6). In this leaflet Du Rietz has given a synoptic key to the species of *Stereocaulon* in Scandinavia, 11 in all.

A. L. S.

Notes on Evernia, Letharia and Usnea.—EINAR DU RIETZ ("Om släktena Evernia Ach., Letharia Zahlbr. emend DR. och Usnea Ach. sub-genus Neuropogon (Nees et Flot.) Jatta," *Svensk Bot. Tidskr.*, 1926, 20, 89-93). Du Rietz gives a preliminary discussion on these related genera and follows with a synoptic key of the genera and species as understood by him. Under *Letharia* he retains only *L. vulpina* and the closely related *L. californica*; the other *Letharia* species are included by him under *Usnea*. Under the sub-genus *Neuropogon* he classifies the arctic species as *N. sulphurea*, the antarctic forms as *U. Taylorii* and *U. aurantiaco-atra*. All these are generally classified under the one species *U. sulphurea*.

A. L. S.

Lecanactis in Brazil.—GUST. A. O. A.-N. MALME ("Die im Regnellschen Herbar aufbewahrten Arten der Flechtengattung Lecanactis (Eschw.) Wainio," *Ark. för Bot.*, 1926, 20, B. N. 2, 1-6). Malme records four species and one variety

Lecanactis insignior var. *fusca*, which is the only representative of the genus that is at all frequent. A. L. S.

Apple Bark Lichens.—S. STUART LIGHT ("The Fauna and Flora of Apple Bark," *Ann. & Mag. Nat. Hist.*, 1926, Ser. 9, 17, 126-49). This study was carried out in the Bristol district. The flora included members of various classes, but the lichen growths were the most numerous, *Evernia*, *Pertusaria*, and *Parmelia* amounting to 74 p.c. of the whole; there were also several crustaceous forms. The species and varieties determined amount to 15. Special attention was devoted to their distribution and situation on the tree. Light found that *Parmelia caperata* was usually situated on the upper region of the trunk, *Evernia prunastri* all over, even to the ends of the branches, and *Xanthoria parietina* about the middle. Towards the foot of the tree the prevailing growths are crustaceous lichens, the commonest being species of *Pertusaria*. The general tendency of these plants is to occur on the leeward side of the tree and on the upper side of the branches.

A. L. S.

Ecology of Heath Lichens.—G. EINAR DU RIETZ ("Zur Kenntnis der Flechtenreichen Zwergstrauch Heiden im Kontinentalen Südnorwegen," *Svensk Vaxtsociolog. Sällsk. Handl.*, 1925, 4, 1-80, 8 text-figs.). In this study Ru Dietz deals with ecology generally in the introduction. He has found that though there appears to be no physical or chemical difference between one locality and another, plants find a distinction which lies at the base of their association. In the more definite accounts of lichen associations in the South Norwegian district he distinguishes two leading types—(a) the *Nanolignosa*, dwarf shrub formation, and (b) the *duri-herbosa*, the grass and herb heath. Of the first of these, *Alectoria ochroleuca* and *Cetraria nivalis* are the dominant types; they occur with a series of small shrubs, such as *Betula nana*, *Arctostaphylis*, *Empetrum nigrum*, etc. The second association is that of higher ground, and other lichens become dominant, such as *Cetraria cucullata*, *C. islandica*, *C. nivalis*, and various species of *Cladonia* and *Gyrophora*. The first group of these associations reaches a height of 1100 metres. Above 1200 metres *Betula nana* disappears and grass heath (with *Dryas*) is the main vegetation.

A. L. S.

Ecology of Corticolous Lichens.—M. & Mme. FERNAND MOREAU ("Observations sur l'écologie et la sociologie des Lichens corticoles," *Bull. Soc. Bot. France*, 1926, Ser. 5, 2, 899-909). The two authors have devoted special attention to the types of lichen plants that form associations on beech, conifers, and ash. The beech woods at Besse (Puy-de-Dôme) are very extensive, offering uniform ecological conditions with a practically uniform growth of lichens, though unimportant variations occur at the edge of the beech woods or on young trees. A limited number of species grow on the smooth bark and under the deep shade of the leaves. Others, such as *Evernia prunastri*, *E. furfuracea*, and *Ramalina farinacea*, are rarely absent from the older trees. On isolated trees in the open a few others occur. In general, *Parmelia sulcata* is the most constant and abundant; the two *Evernias*, with *Lecanora subfusca* and *Lecidea parasema*, are also abundant. All other species are of minor importance. On exposed surfaces of the trunk crustaceous species are the pioneers and retain predominance. Their thallus, embedded in the bark, is scarcely affected by wind influence, though in extremely open situations storms of rain and hail may damage the bark and also the lichens. *Parmelia sulcata*, though abundant, may be dispossessed by shrubby forms, more especially in well-lighted positions. *Parmelia saxatilis* occupies the base of the trees, probably owing to the greater moisture there. On conifers *Parmelia physodes* is abundant.

The larches are the richest in lichen covering, *Evernia furfuracea* the dominant species where the trees are well lighted. *Pinus silvestris* and firs are poor both in species and in individuals. The authors have observed that some species showed preference for substances such as resin; certain groups require light and air, while others, such as *Parmelia sulcata*, seem to prefer shaded positions, and it is probable that these depend to a larger extent on the substratum for their carbohydrates. They found that *Lecanora subfusca* and *Lecidia parasema* occupied the young beeches, *Parmelia sulcata* the older and more sheltered, *Evernia furfuracea* those on the edge of the forest. *Parmelia scortei* they found abundant on an isolated group of ash trees.

A. L. S.

Mycetozoa.

Australian Mycetozoa.—J. BURTON CLELAND ("Notes on a Collection of Australian Myxomycetes," *Trans. and Proc. Roy. Soc. S. Australia*, 1927, 51, 62-4.) The Mycetozoa were collected during Cleland's study of Basidiomycetes. Notes and observations were recorded, and the whole collection was finally revised by Gulielma Lister. Altogether, 31 species are enumerated, six of them new to Australia. One of these, *Perichæna depressa*, had been collected by W. Cheeseman at Hawkesbury River.

A. L. S.

Danish Myxomycetes.—W. T. ELLIOTT ("Danish Myxomycetes Contained in the Botanical Museum of the University of Copenhagen," *Bot. Tidsskr. Kjøbenh.*, 1927, 39, 357-67). The curator of the museum, in a preliminary note, tells how he requested the help of Dr. Elliott in revising the whole of the Myxomycetes in the museum. The collection has proved to be well representative of the Danish Myxomycete flora, embracing 29 genera and 83 species. Localities and notes descriptive and biological are given.

A. L. S.

Methods of Nuclear Division in the Plasmodiophorales.—W. R. IVIMEY Cook (*Ann. Bot.*, 1928, 42, 347-77, 2 pls.). It has long been recognised that two types of nuclear division occur in this group of fungi. Cook gives an historical account of the work already done. His own researches were carried out on *Ligniera*, and the material used was the infected roots of *Callitriche stagnalis*. The first type of nuclear division occurs in the amoebæ and has been termed a protomitosis; the second is a true mitosis and is represented in the two divisions which precede spore and zoospore formation. In protomitosis there is formed a hollow disc of chromatin which splits into two equal plates; these travel to the poles along spindle fibres; the karyosome, a spherical body, becomes drawn out and separates into two spheres, which follow the chromatin plates. Protomitosis is rapidly passed through, all the divisions are alike, and all the nuclei in the same amoeba divide simultaneously. The mitosis division is also described; chromosomes were too minute to be counted. No evidence of nuclear fusion has been found. Protomitosis is a primitive type of division and occurs only in Plasmodiophorales. The group may have become separated before the higher Mycetozoa were evolved; they show no kinship with Chytridiales.

A. L. S.

Myxobacteria of Poland.—HELENA I SEWERYN KRZEMIENIEWSKY ("Mikso-bakterie Polski. Uzupełnienie," *Acta Soc. Bot. Pol.*, 1927, 5, N. 1, 79-98, 3 pls.). Polish, with German résumé. The author has by further studies enlarged the knowledge of these small organisms by describing new varieties or forms or by adding biological notes. The species were cultured on rabbit excreta mixed with soil, and several of them were successfully transferred to agar. Two species, *Sorangium septatum* and *S. sorediatum*, were grown on agar up to the fruiting stage.

A. L. S.

TECHNICAL MICROSCOPY.

The Beck Pathological Microscope.—Mr. Conrad Beck has designed a new microscope for the London School of Hygiene and Tropical Medicine (fig. 1). The base is of the horse-shoe pattern and has a spread of $5\frac{1}{2}$ inches

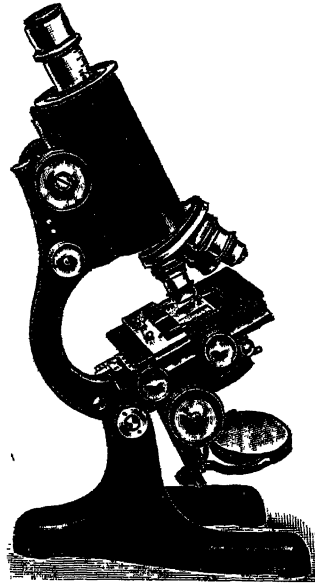


FIG. 1.

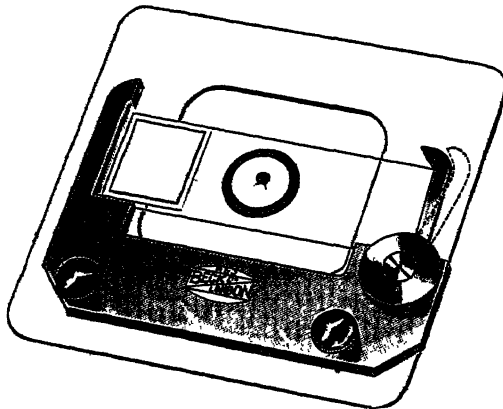


FIG. 2.

by $7\frac{1}{2}$ inches, the base and pillar being cast in one piece. The body tube is 2 inches in diameter, the draw-tube having at its lower end a standard R.M.S. objective thread to enable very low-power objectives to be used, if desired. The mechanical stage is of the built-in type. It has a movement of 1 inch in the

vertical and $1\frac{1}{2}$ inches in the horizontal direction. The two milled heads for operating the movements are situated below the level of the surface of the stage, so that objects much larger than the stage can be examined without fouling the controls. The actuating milled heads are normally on the right-hand side, but, to prevent obstruction when using a camera lucida, the School of Hygiene have determined to have the controls on the left. An attachable top plate is provided for holding 3×1 inch slips (fig. 2), which are firmly held in position by means

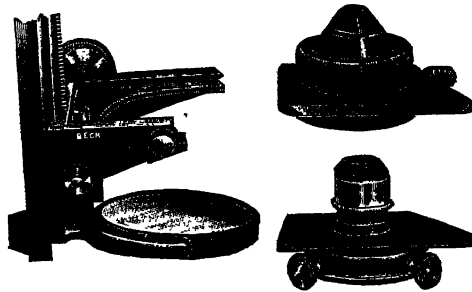


FIG. 3.

of an arm actuated by an eccentric, no springs being used. The substage is focussed by rack and pinion, and the condensers are carried in Akehurst changers (fig. 3), a method that allows of rapid and convenient interchange of any substage illuminators. The objectives are enamelled in distinctive colours, so that students

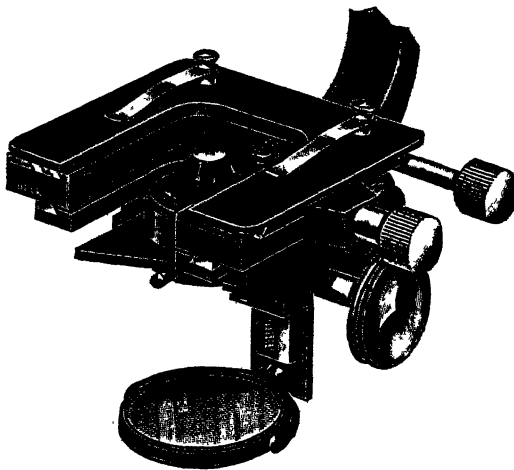


FIG. 4.

shall have no difficulty in identifying them when in position on the instrument, a method suggested some years ago by the British Science Guild. The usual Beck two-speed fine adjustment is fitted. In one model the front of the stage is cut away to allow condensers to be withdrawn without lowering the substage or interfering with the adjustments (fig. 4).

F. V. W.

Microscopical Examination of Fat Emulsions Used in the Leather Trade.—W. SCHINDLER (*Collegium*, 1928, 12–20). An account of a microscopical investigation into the effect of the pH value on the emulsification properties of soaps and soluble oils. A. H.

Microscopical Investigation of the Dregs of Wine as a Means of Detecting Fruit Wine.—A. WIDMER and O. E. KALBERER (*Z. Unters. Lebensm.*, 1927, 53, 193–208). The differentiation of grape and fruit wine is based on the high starch content of the dregs in the case of the latter. Grape must also contain starch, but when the dregs are found to be rich in starch cells, especially when round grains are seen, the wine is looked upon with suspicion. A further paper on the detection of cider in wine by microscopical methods has since appeared in *Z. Unters. Lebensm.*, 1927, 54, 387–88. A. H.

Microscopical Examination of Quartzites and Lime-Quartz Bricks, Silica Bricks, Dinas Bricks.—J. E. HIBSCH (*Feuerfest*, 1926, 2, 93–5, 113–17, through *Chem. Abstr.*, 1928, 22, 1661). The microscopical differences between rock quartzite and amorphous "cement" quartzite are dealt with. Rock quartzites, which are considered to be silicified sandstones, consist of uniform quartz grains, with mica present but never opal. Cement quartzite has the grains embedded in an opaque matrix, and mica is never present. In the examination of quartzite, very thin sections are necessary. A. H.

Micrography of Paint Films.—E. STERN (*Korrosion Metallschutz*, 1927, 3, 153–59). Paint films were exposed to the action of acid, alkali, steam and water, and examined microscopically. Stand oil was found to be more resistant than linseed oil. A. H.

NOTICES OF NEW BOOKS.

Traité d'Embryologie comparée des Invertébrés.—By C. DAWYDOFF. 1928. xiv, 930 pp., 509 text-figs. Published by Masson & Cie., 120, Boulevard Saint-Germain, Paris VI^e. Price 120 fr.

Traité de Zoologie.—By EDMOND PERRIER. Part VIII. Développement embryogénique des Vertébrés Allantoïdiens.—Les Reptiles. 1928. 233 pp., 228 text-figs. Published by Masson & Cie., 120, Boulevard Saint-Germain, Paris VI^e. Price 40 fr.

Index Animalium.—By C. D. SHERBORN. Part XIII, pp. 3137–3392. Part XIV, pp. 3393–3746. 1927. Published by the British Museum (Natural History), Cromwell Road, London, S.W. 7. Price 10s. each part.

Bibliography of Sponges, 1551–1913.—By G. C. J. VOSMAER. 1928. xii, 234 pp. Published by the Cambridge University Press, Fetter Lane, London, E.C. 4. Price 15s.

Atomic Structure as Modified by Oxidation and Reduction.—By WILLIAM COLEBROOK REYNOLDS, D.Sc. 1928. vi, 128 pp., 11 text-figs. Published by Longmans, Green & Co., Ltd., 39, Paternoster Row, London, E.C. 4. Price 7s. 6d.

The Microscopy of Drinking Water.—By G. C. WHIPPLE. 1927. 4th Edition. Revised by G. M. FAIR and M. C. WHIPPLE. xix, 586 pp., 123 text-figs., 26 plates. Published by Chapman & Hall, Ltd., 11, Henrietta Street, Covent Garden, London, W.C. 2. Price 35s.

An Introduction to the Theory and Use of the Microscope.—By C. R. MARSHALL, M.A., M.D., LL.D., and H. D. GRIFFITH, B.A.

This book was written for students and amateur microscopists, and its inspiration is the result of the institution of lectures and practical work on microscopy as part of the class in medical physics at the University of Aberdeen. In this respect it stands almost alone, as at few universities is any specialised teaching given in this subject, with the result that most books on microscopy are written by amateur workers.

In addition to a simple but sufficient account of practical methods, a chapter is added on elementary mathematical theory which cannot fail to be of interest to any microscope users who wish to understand the optical principles of the microscope. In its arrangement the work proceeds on orthodox lines, its introduction consisting of a lucid account of the formation of images by simple optical systems. It includes an account of the effect on visibility of the refractive index of a medium in which any object is immersed, a point of the greatest interest to microscopists, as all images are seen in the microscope either as the result of differences of refractive index between an object and its surroundings or of differences of colour. Photographs of ordinary objects are shown to illustrate these points. Microscope objectives are next dealt with, the aberrations to be expected in all lens systems are described, and the extent to which these aberrations are eliminated is indicated. Numerical aperture, depth of focus, and the effect of depth of accommodation, working distance, flatness of field, magnifying power, and finally critical illumination, are all adequately dealt with. Photographs of illuminating cones produced by various condensers are included which are of value. A simple exposition follows of resolution, and some illustrations of a well-known diatom serve to bring home to the reader the effect of varying the working N.A. A short description of stands and illuminants provides some essential information, without the illustrations and descriptions from makers' catalogues so usually provided in such books. Chapters on adjustment and micrometry are of value, but the quite inadequate paragraphs on photo-micrography might well have been omitted. Finally a description of some microscopes and apparatus for special purposes is provided, together with a chapter on physical proofs. The latter is, in some respects, the most interesting section. It provides a simple, understandable account of the theory of image formation in the microscope that is difficult to find elsewhere, and that will give to many all the theoretical knowledge they need. The book deserves, and should have, a wide sale.

J. E. B.

Seed Testing.—By JOHN STEWART REMINGTON. 1928. xi, 144 pp., 33 text-figs. Published by Sir Isaac Pitman & Sons, Ltd., 3, Parker Street, Kingsway, W.C. 2. Price 10s. 6d. net.

It is perhaps an unfortunate commentary on commercial probity that seed testing stations should ever have become necessary, although, as is pointed out in this book, they arose rather through ignorance than from deliberate dishonesty. The conditions under which seeds were sold were far from desirable, but since the Seeds Act, 1920, a seedsman has to declare the quality of certain kinds of seeds. The book describes the methods of establishing the quality of seed samples according to the criteria demanded. An account is thus given of aims and methods of

seed testing, the chief difficulties encountered, and the principal weeds whose seeds pollute samples of clover and grass seed. The methods described are adapted to official requirements, and, having borne the test of experience, are to be respected accordingly. So far, the book fulfils the function suggested on the jacket, of explaining "how, without expensive apparatus, any seed merchant can test the purity and germinating quality of his seeds, and thus check the value of his proposed purchases. The work will also prove valuable to farmers, agricultural students, and gardeners, who can easily apply the up-to-date methods which it describes." It is difficult, however, to feel equally satisfied throughout. There are some misprints, particularly in the spelling of names of plants, and, as the errors are not consistent, it is fair to assume carelessness on the part of either or both author and printer. If scientific names are to mean anything, they must be correct, and a competent botanist would have detected most of the errors at a glance.

Many points of general interest are raised by seed testing, although it must be kept in mind that in practice only a comparative estimate of germinative capacity is required. Nevertheless, it is doubtful whether germination on moist filter paper is equally suited to all seeds. It is only necessary to refer to the special methods required to germinate mycorrhizal plants, such as orchids, to emphasise this point.

Some attention is devoted to the problem of "hard" seeds. It is difficult to discuss problems of stored seeds without further embittering the controversies about "mummy" wheat. Dorph-Petersen has shown that farm seeds retain considerable germinative power up to seven years, but it has also been shown that drastic treatment with concentrated sulphuric acid and suitable heat will induce water-lily seeds from peat to germinate! To some extent "hardness" of seeds can be related to storage conditions, and, although germination is apt to be slow, the author is certainly justified in concluding that "hard" seeds should be included in the report.

The illustrations are not all that could be desired, and probably line drawings, with no shading, would have been more helpful.

The fact that the author explains in the preface some of the book's peculiarities does not necessarily condone them. It is, for example, a little unexpected to find the clover weevil and pea and bean beetle illustrated, while no mention is made of common fungi. "Damping-off" disease, for example, is a well-known tribulation, and it is known that in general terms its appearance is restricted by acid conditions. It would have been useful to have had the benefit of the author's experience on this and kindred points. Altogether, the book is quite useful, but is capable of improvements for its second edition.

E. H. E.

The British Sea Anemones.—Vol. I. By T. A. STEPHENSON, D.Sc. The Ray Society, London, 1928.

Since the publication of "*Actinologia Britannica*," by P. H. Goose, in 1860, no monograph has appeared on the British sea anemones, although before the war such a work had been begun by Professor G. C. Bourne and Dr. C. L. Walton, who, however, were unable to complete it. Dr. Stephenson has now succeeded in finishing the monograph, which deals primarily with actinian morphology. The morphological account has, however, been built up from living material as well as from anatomical study, with the result that the physiological and bionomical points of view have not been entirely neglected. After describing the anatomy and histology of sea anemones, the question of colouration is shortly discussed. This is a subject on which but little work has been done. Development, distribution,

motion, feeding, reproduction, enemies, commensalism and symbiosis, are all described in detail, while there is a useful section on methods for collecting and keeping sea anemones. The volume ends with a discussion of the classification and a list of the British actinaria. Special mention must be made of the fourteen plates, ten of which have been exquisitely reproduced in colour. G. M. F.

BOOKS PURCHASED FOR THE LIBRARY.

The Biology of the Protozoa.—By GARY N. CALKINS. 1926. ix, 623 pp. 238 text-figs.

Foraminifera.—Their Classification and Economic Use. By J. A. CUSHMAN. 1928. 401 pp., 59 plates.

Kryptogamen-Flora von Deutschland, Osterreich und der Schweiz.—Vol. VII. Die Kieselalgen. By F. HUSTEDT. Part 1, 272 pp., 114 text-figs. 1927. Part 2, 192 pp., 144 text-figs. 1928.

Atlas der Diatomaceen-kunde.—By A. SCHMIDT. Parts 70–92. Plates 289–362.

PROCEEDINGS OF THE SOCIETY.

AN ORDINARY MEETING

OF THE SOCIETY WAS HELD AT 20 HANOVER SQUARE, W. 1, ON WEDNESDAY, JUNE 6TH, 1928, MR. JOSEPH E. BARNARD, F.R.S., PRESIDENT, IN THE CHAIR.

The Minutes of the preceding Meeting were read, confirmed, and signed by the President.

New Fellows.—The following were balloted for and duly elected Ordinary Fellows of the Society :—

Walter Martyn Else.
F. W. Harris.
Sydney Gibson Laws.
Edward G. T. Roberts.
Albert Reginald Yarwood.

The Death was announced of Mr. Charles James Tabor. Elected 1911.

A vote of condolence with the relatives was passed.

The following paper was read in title :—

Mr. E. Heron-Allen, F.R.S., and Mr. Arthur Earland, F.R.M.S. :—

“ On the Pegididæ, a new Family of Foraminifera.”

THE ANNUAL POND LIFE AND GENERAL MICROSCOPICAL EXHIBITION.

The following objects were exhibited by Fellows of the Society and Members of the Quekett Microscopical Club :—

Mr. F. Addey, F.R.M.S.	.. ..	<i>Polyphemus pediculus.</i>
Mr. A. J. Bowtell, F.R.M.S.	.. ..	Water-Mite (<i>Arrhenurus crassicaudatus</i>).
Mr. D. Bryce, F.R.M.S.	.. ..	<i>Encentrum hudsoni</i> , one of the rarest British Rotifers.
Rev. Canon G. R. Bullock-Webster, F.R.M.S.		Fruits of Charophytes, recent and fossil.
Mr. F. W. Chipps	.. ..	<i>Vallisneria spiralis</i> , showing cyclosis, also <i>Cristatella mucedo</i> and <i>Fredericella sultana</i> .

Dr. J. D. Coales, F.R.M.S.	..	<i>Coriza</i> , sp. (young).
Dr. W. R. I. Cook .. ..	..	<i>Cystochytrium radicale</i> , g. et sp. n., parasitic in roots of <i>Veronica becca-</i> <i>bunga</i> . <i>Sorosphaera radicale</i> , sp. n., parasitic in root-hairs of a species of grass.
Mr. E. Cuzner, F.R.M.S. .. ..	..	<i>Volvox aureus</i> , some with oospores, and <i>Peridinium</i> sp.
Mr. M. T. Denne, O.B.E., F.R.M.S.	..	<i>Tradescantia</i> showing cyclosis.
Mr. H. E. Hurrell, F.R.M.S. ..	..	<i>Cristatella mucedo</i> .
Mr. H. J. Lawrence .. ..	..	<i>Daphnia hyalina</i> with ectoparasitic Rotifers (<i>Brachionus rubens</i>).
Dr. J. A. Murray, F.R.S., F.R.M.S.	..	Diatoms (<i>Pinnularia</i> , etc.) "stained" in hæmoglobin iron-hæmatoxylin; also sections of newly-hatched larva of leech (<i>Clepsine</i> sp.).
Mr. C. H. Oakden, F.R.M.S. ..	..	Water-Mite (<i>Arrhenurus tricuspidatus</i>) and larva of Mosquito (<i>Anopheles</i> sp.).
Mr. D. J. Scourfield, F.R.M.S. ..	..	<i>Daphnia hyalina</i> slightly stained <i>intra</i> <i>vitam</i> with methylene blue and neutral red. Feeding on a very minute alga (? <i>Chlorella</i> sp.), only $\frac{1}{10,000}$ in. to $\frac{1}{15,000}$ in. diameter.
Mr. R. S. W. Sears, F.R.M.S. ..	..	<i>Vorticella</i> sp.
Mr. B. J. Thomas .. ..	..	<i>Fredericella sultana</i> ; also <i>Acineta</i> sp.
Dr. C. Tierney, F.R.M.S. ..	..	<i>Amœba proteus</i> and <i>Menoidium</i> sp.
Mr. G. R. Titchener, F.R.M.S. ..	..	Larva of <i>Corethra plumicornis</i> .
Mr. W. R. Traviss .. ..	..	<i>Meliceria ringens</i> .
Mr. J. Wilson, F.R.M.S. ..	..	<i>Eudorina elegans</i> , <i>Pandorina morum</i> , and various Desmids (<i>Closterium</i> sp., <i>Xanthidium antilopum</i> , etc.).

The President called upon Mr. D. J. Scourfield to describe the Pond Life exhibits. Mr. Scourfield observed that, owing perhaps to there being at least two other important events taking place that evening, the exhibition was not quite so representative as usual. He gave a brief description of the exhibits, in the course of which he called attention to many interesting points of structure, and dealt especially with the biology of the organisms in relation to their environment, and to the difficulty of differentiating between plant and animal forms in some of the lower orders.

On the motion of the President, a hearty vote of thanks was accorded to the Members of the Quekett Microscopical Club, to the Fellows of the Royal Microscopical Society, who had contributed to the exhibition by bringing specimens, and to Mr. Scourfield for his descriptive remarks.

The President announced that the Rooms of the Society would be closed for the Summer Vacation from August 20th to September 15th.

There being no further business, the meeting then resolved into a conversazione.

JOURNAL
OF THE
ROYAL MICROSCOPICAL SOCIETY.
DECEMBER, 1928.

TRANSACTIONS OF THE SOCIETY.

XIII.—AN ELECTRICALLY-HEATED WARM STAGE AND COMPRESSOR FOR USE WITH HIGH-POWER OBJECTIVES.

By J. E. BARNARD, F.R.S., P.R.M.S., and F. V. WELCH, F.R.M.S.

(Read October 17, 1928.)

ONE PLATE AND ONE TEXT-FIGURE.

THE observation of small living objects under the microscope frequently involves the use of some appliance for maintaining a temperature at which such organisms can freely grow and multiply. This is usually accomplished either by means of a warm chamber or a warm stage. The former is similar to an incubator, is made with double-jacketed walls like a water bath, the microscope in its entirety being placed inside. The latter is normally in the form of a holder—the temperature of which can be suitably raised—on which the object slide is placed.

Both methods of temperature control have disadvantages, although each has points of convenience in use. The main objection to the chamber type is that it is complicated to run and expensive to make. Further, it must be so designed that all microscope adjustments can be made from outside. Thus all milled heads on the microscope—the fine adjustment control particularly—must be provided with extensions which project through the box. When it is necessary to change the preparation, the microscope is usually withdrawn bodily, with the resulting possibility of alteration of its position in relation to the light, or disturbance of some

other instrumental adjustment. Its advantage is that temperature can be maintained at a constant level over long periods. In any stage heater it is difficult to ensure that the object slide is kept at a reasonably regular temperature, as the small heating surface and the inevitable distance of the heating element from the object result in considerable fluctuations. Such heaters are simple to use, the object is easily changed, and the microscope adjustments are accessible, but for the purpose for which they are designed they are inefficient.

The model about to be described has been designed with the object of combining the advantages of both types. It consists of a small box made of non-conducting material—substantially as shown in fig. 1—which encloses the heating system, the whole of the microscope stage with object holder, objective and substage illuminator. This box or hood is made in two parts, one of which (A) is attached to the nosepiece, and the other (B) which simply slides on or off without any fixing arrangement. There are two heating elements which are clamped on the under side of the stage, one on each side of the condenser (fig. 2, C). It will be appreciated that the appliance as described is only suitable for use on a microscope with a square metal stage, although it could easily be made to suit a circular stage with slight modification. Electrical current is supplied to these heaters through leads DD, and these are connected to the mains in series with any suitable variable resistance. In operation, the air inside the box is raised in temperature, and the containing hood behaves as a heat trap. Both the stage and the compressor are therefore maintained at a constant temperature as they are within the same container. The compressor (fig. 3, E) is an essential part of the system, as it is designed to assist in the maintenance of any desired temperature. As described, it is intended for use with a Beck high-power dark-ground illuminator, 1.27 N.A., which to be used at its best necessitates the use of two cover-glasses, between which the material to be examined is placed. Such cover-glasses are held in a block of brass measuring 3 ins. \times $1\frac{1}{2}$ ins. \times $\frac{1}{2}$ in. When the temperature of such a relatively large mass of metal is raised, it does not alter rapidly—in fact, it changes but little during the time taken to replace material under examination. Temperature is indicated by means of a thermometer (F) which is inserted through a hole in the side of the block so that the bulb comes close to the preparation. The compressor in section is shown in fig. 4. It consists of two parts—G, which is the metal receptacle for the cover-glasses, and H, a funnel-shaped tube which drops into the hole in G in the position indicated by the dotted lines, and holds the cover-glasses by gravity on the annular ledges KK. The funnel is made with an angular bottom edge (LL) as shown, which just engages the edge of the top cover-glass. In practice this has been found entirely satisfactory, as no disturbance of the preparation takes place during manipulation of the mechanical stage of the microscope. The inside of the funnel is nickel-plated, so that light is reflected from its

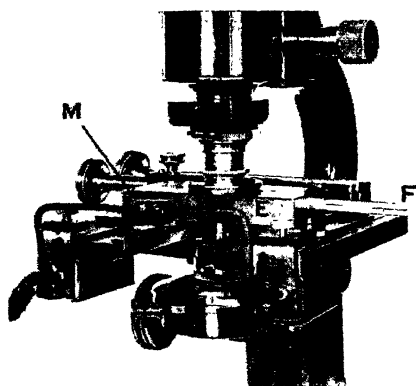


FIG. 8.

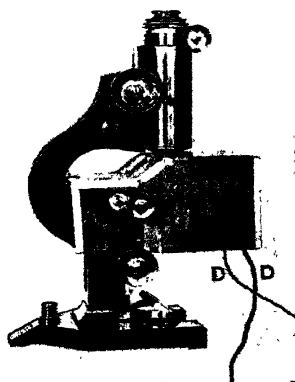


FIG. 1.

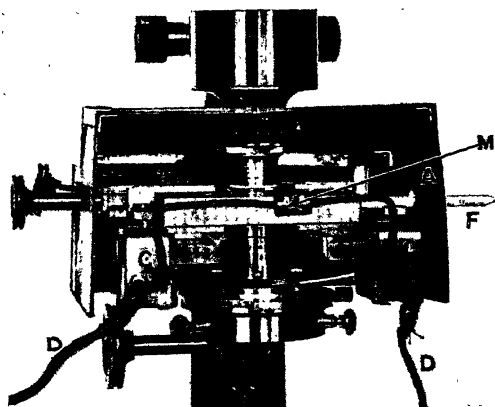


FIG. 2.

sides as soon as the objective is immersed. This is a point of some importance, as the thickness of the compressor makes it difficult to observe the process of immersing the objective in the ordinary way.

Some mechanical details of construction may be given. The two-piece box is made of hard compressed cardboard about $\frac{1}{8}$ inch thick. This material was chosen, after some experimenting, as it is cheap, light in weight, and conducts heat badly. It is cut to a suitable shape with a sharp knife and then bent to the required form. Where necessary, as shown in fig. 1, the corners are strengthened by aluminium angle-pieces which are riveted on with aluminium wire. A slot must be left in a suitable position at one side for the mechanical stage controls to come through, and another at the opposite side for the thermometer. Such an appliance is within the constructional ability of many engaged in laboratory work. The electrical heaters are made of 36 S.W.G. enamelled resistance wire. A length of this wire to suit the current supply is wound on to a piece of asbestos-covered brass tube about $1\frac{1}{4}$ ins. long and about $\frac{1}{2}$ in. in diameter.

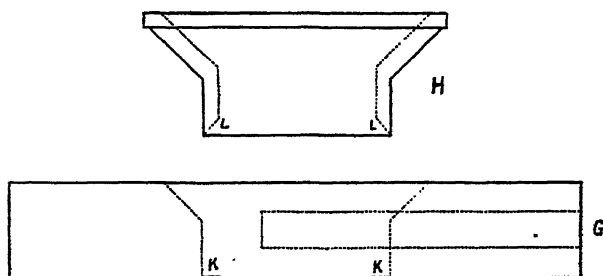


FIG. 4.

Each heater is enclosed in a rectangular brass box provided with a clamping screw to attach the unit to the under side of the microscope stage. A wire runs from one to the other, so that the windings are in series, and they can be disconnected from one another at the point M (figs. 2 and 3) by means of a simple vulcanite connector. The external variable resistance is wound with 32 S.W.G. enamelled resistance wire on an asbestos-covered brass tube about 12 ins. long by 1 in. diameter, and variation of current is effected by means of a slider in the orthodox way. On any ordinary lighting circuit from 240 volts downwards such a resistance will allow temperatures between 20° C. and 50° C. to be maintained with certainty.

It will be found that drying of the preparation—a very common trouble in work of this kind—does not occur if sufficient immersion oil is used. The oil spreads under the edge of the compressor funnel and effectively seals the junction of the two cover-glasses.

The apparatus described was designed for use in an investigation on bacteriophagic action involving observations of living bacteria for long periods. For this purpose it has proved entirely satisfactory.

XIV.—TWO NEW CILIATES FROM SEWER WATER.

By EKKENDRANATH GHOSH, M.Sc., M.D., F.Z.S., F.R.M.S.,
Professor of Biology, Medical College, Calcutta.

(Communicated by DR. C. TIERNEX, October 17, 1928.)

THREE TEXT-FIGURES.

1.—PRORODON STEWARTI sp. n.

BODY elongately oval (pillow-shaped), less than twice as long as its greatest transverse diameter, and slightly tapering and rounded at both ends. Cilia are arranged in close meridional rows. Cytostome anterior and

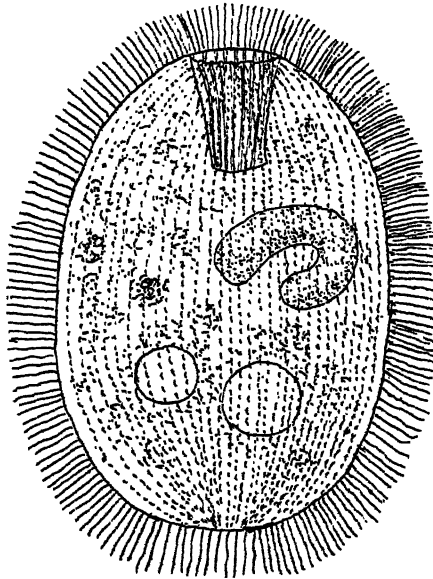


FIG. 1. $\times 460$.

slightly lateral. Cytopharynx truncately conical, from one-fourth to one-third the body length. Rod apparatus distinct. Macronucleus horseshoe-shaped, stout, and placed on one side slightly in front of the middle of the body. Micronucleus could not be detected. Two con-

tractile vacuoles, spherical in shape and placed one a little in front of the other, in the posterior body half.

Length 0·14 to 0·15 mm.

Several specimens were detected in the sewer water from Calcutta. The present species differs from all known forms in having a short, stout, horseshoe-shaped macronucleus and two large contractile vacuoles.

2.—*OPISTHOSTOMUM BENGALENSIS* gen. n., sp. n.

Body elongately and irregularly oval, being less than twice as long as its greatest transverse diameter; body broadly oval in transverse sections. Anterior end somewhat tapering and rounded. Posterior end with three lobes: a large ventral lobe, a somewhat triangular lobe on the dorso-lateral aspect and to the left, and a narrow elongated lobe on the right side somewhat projecting on the dorsal aspect. Seen from the dorsal aspect, the left dorsal lobe projects beyond the ventral one along

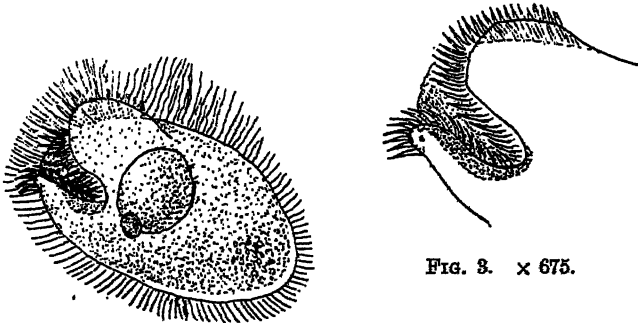


FIG. 2.

FIG. 3. $\times 675$.

its left margin and is two-fifths of the body length; a deep furrow separates the ventral from the left dorsal lobe. The right lateral lobe is separated from the ventral lobe by a small shallow notch. The right and left lateral lobes are separated from each other by a deep somewhat narrow gap. Peristome on the dorsal aspect of the ventral lobe in the form of a long narrow excavation extending on the inner ventral aspect of the right lateral lobe. Peristome appears to be naked. A row of well-developed membranelles extending along the entire left border of the ventral lobe, continued along the right margin of the same lobe to the left margin of right lateral lobe and ending at the junction of the present lobe with the ventral one. Body uniformly ciliated, the cilia along the left side being very long. A layer of distinct clear ectoplasm. Endoplasm granular. Macronucleus large, oval, and placed in the posterior body half. Micro-nucleus spherical, on the right side of the macronucleus.

Length 0·078 mm. Breadth 0·048 mm.

This peculiar ciliate was found in large numbers in sewer water from Calcutta. The presence of membranelles and uniform and complete body ciliation show that it belongs to the section Polytricha of the order Heterotrichidea. The postero-terminal position of the peristome with a well-developed row of membranelles and the presence of lobes at the posterior end are enough to erect a new genus, *Opisthostomum*, for it.

The genus *Opisthostomum* may be thus defined: Body oval. Peristome narrow, postero-terminal, surrounded by a large ventral lobe, a large left dorso-lateral lobe, and a small right dorso-lateral lobe. A single sinuous row of well-developed membranelles in the peristome.

The family position of the animalcule is doubtful. Perhaps a new family is to be created for its reception.

XV.—TRIPOD AND PILLAR MICROSCOPES.

By W. H. VAN SETERS (Amsterdam).

(Communicated by DR. C. TIERNEY, November 21, 1923.)

ONE TEXT-FIGURE.

IF by "microscopes" we mean instruments which enable us to magnify small objects, we should, in connection with their optical construction, distinguish between three groups:—(1) The simple microscope; (2) the telescope-microscope; (3) the compound microscope, or microscope properly so-called.

The history of the first group dates from very olden times, when simple lenses were first used.

For practical reasons the second group proved incapable of much improvement. By the term telescope-microscope we mean a special application of the Dutch or Galilean telescope, dating from the beginning of the seventeenth century, and, in illustration of this, we would refer to "De uitvinding der verrekykers" ("The Invention of Telescopes"), 's Gravenhage, 1906, p. 293 *seq.*, by C. de Waard, Junr.

For scientific purposes the third group gradually became the most important of the three.

From the commencement of the seventeenth century the compound microscope has passed through a very interesting period of development. It shows, not only an optical, but also a mechanical evolution, and it is to a detail of the latter, viz. the manner of fitting the tube, that I wish to draw your attention.

In the seventeenth and especially in the eighteenth centuries we constantly meet with two types of microscope, viz. the tripod microscope and the pillar microscope.

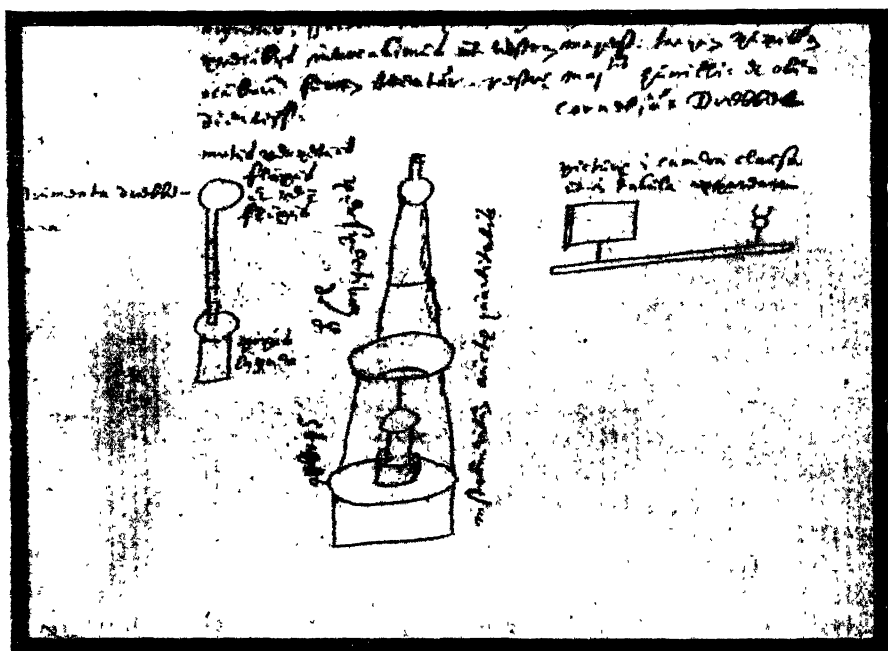
A description of the earliest tripod microscope is found in the well-known letter to Petrus Porellus of Willem Boreel, Dutch Ambassador in France (Petrus Borellus: *De vero telescopii inventore*: Hagae Comitum: 1655, p. 24):—"tubus . . . insidens tribus delphinis ex aere, itidem subnixis, in basis disco ex ligno ebano." The instrument was made by the brothers Janssen and was seen in 1619 by Boreel in the possession of Cornelis Drebbel.

In 1622 observations were made by De Peiresc (MS. N. C. F. de Peiresc :

Bibliothèque de Carpentras, No. 1774, fol. 407 verso) with a microscope constructed by Cornelis Drebbel. De Peiresc gives the following description of this instrument: "Cest instrument s'enchassoit dans un petit cercle de cuivre doré porté par trois petits pieds arreztez sur un petit plot comme si c'estoit la molette d'une escrितtoire. . . ." So this again was a tripod type.

The photographic reproduction given herewith is from a sketch by Isaac Beeckman of one of Drebbel's microscopes. This drawing dates from about 1631, and, however faulty it may be, it doubtless shows a tripod microscope.

Although a reproduction of a counter-drawing of this sketch may be



found in Dr. H. A. Naber's work "De ster. van 1572, Cornelis Jacobsz Drebbel," Amsterdam, 1907, p. 29, yet the original has not been previously photographed, and, as it is not generally known, I will dwell upon it a little longer ("De uitvinding der verrekijckers," by C. de Waard, Junr., 1906, p. 149).

Isaac Beeckman, born December 10th, 1588, at Middelburg, Holland, was Doctor Medicinæ at that town; later on he became Rector of the Latin School at Dordrecht. He was an excellent mathematician, and kept up relations with numerous physicists and mathematicians of his day. He died in 1637, and has left us a diary (MS. Provinciale Bibliotheek van Zeeland, Middelburg) running from about 1612 up to 1635. This diary

contains 472 folio pages, numbered 1-394. The sketch in question will be found in the middle of the page 295, under a letter copied by Beeckman and written by Cornelis Drebbel to James I, King of England. This letter is dated about 1613, but was inserted by Beeckman into his diary on March 15th, 1631, as appears from the following entry (p. 379): "Gisteren synde den 15 Meerte 1631 hebbe ick eenen brief van Cornelis Drebbel aan de Coninck van Engelandt geschreven, hiervoor op een ledich bladt gecopieert. . . ."

In this letter no reference whatsoever is made to microscopes. C. de Waard, Junr., who, in connection with his excellent publication on the invention of telescopes, has made a special study of this manuscript, informed me that he does not consider the original sketch to be contemporaneous with the letter. So we may not date the microscope itself from 1613, but it is evident that it was made before 1631.

As Professor F. M. Jaeger, in his "*Cornelis Drebbel en zyne tydegennooten*" (Groningen, 1922, p. 134, note), has remarked, a closer examination of the sketch shows that it does not correspond to De Peiresc's description of Drebbel's microscope.

On the left-hand of the page we read "*instrumenta drebbeliana*"; on the left-hand of the microscope "*perspectivum d (?)*" and "*stapes*"; on the right-hand side "*instrumentum auctor quantitatis*."

If the two microscopes in the Museo di Fisica at Florence are to be ascribed to Galileo ("*Origin and Development of the Microscope*," R.M.S., 1928, p. 107), they date back to before 1642; they are likewise of the tripod type, but without pedestal.

It is scarcely necessary to mention the "Charles I Microscope," because its date is confidently ascribed to the latter part of the seventeenth century (J. R.M.S., 1889, 9, pp. 440-2), and, moreover, we know various definite tripod types of that period, all without mirror, such as Campani, Divini, Grindl von Ach.

In the eighteenth century the tripod type developed into the elegant but unpractical model of Culpeper and Scarlett.

The earliest figure of a pillar microscope is to be found in Robert Hooke's "*Micrographia*" (1665). It would take too long to discuss here all types of this instrument without and, later, those with mirror. The pillar type has maintained itself till modern times, contrary to the tripod type, which disappeared at the end of the eighteenth century.

One may now ask oneself two questions: (1) Which of the two types is the older? And (2) Why was it necessary that the tripod type should disappear?

In my opinion the tripod type was the oldest, and I think that the above-mentioned data all point in that direction. I observe, further, that my view is shared by Messrs. Clay and Court ("*Development of the Culpeper Microscope*," J.R.M.S., 1925, 45, p. 167), who say: "The earliest form of mounting for a microscope was the tripod, which was in

general use for spheres and globes at the beginning of the seventeenth century."

The principal drawback of the tripod type manifested itself after the introduction of the mirror; the stage, fixed between the three legs, was not accessible from all sides, and did not admit of as much freedom of movement as is required for the handling of the object-slides.

Moreover, the pillar microscope shows an advantage on account of the possibility of different constructions for finer adjustment. With the tripod microscope the fine adjustment was mostly done by hand, although screw adjustment has also been applied.

These two drawbacks caused the tripod microscope with mirror to disappear, as we have pointed out, during the second half of the eighteenth century, except in the cheap wooden Nuremberg tripod type, which maintained itself till a later date. At the same time it must be admitted that the tripod type had its advantages, for it has been revived in the wooden metallurgic microscope, and is found to be still useful when opaque objects are to be examined.

XVI.—A CONTRIBUTION TO THE CYTOLOGY OF THE OVULE OF OROBANCHE MINOR.

By KATHLEEN M. CARTER, M.Sc., Royal Holloway College.

(Communicated by Prof. R. R. GATES, November 21, 1928.)

SIX PLATES AND SIX TEXT-FIGURES.

INTRODUCTION.

As a result of an investigation of the flower buds of *Orobanchë minor*, some account is given here of the development of the ovary, ovules and stamens. This is followed by an account of a more detailed study of the nucleus of the megaspore mother-cell, of its meiosis and of the later mitotic divisions in the embryo sac.

The material was collected during the last week of June, 1925, in the Botany Garden of Royal Holloway College and in the gardens of the Department of Agricultural Botany, the University, Reading. The *Orobanchë* was parasitic on teasel in the Royal Holloway College Garden and on four hosts, red clover, wild white clover, chamomile and parsnip, in the gardens at Reading. The material was fixed at various times of the day, some in the field, and some from flowering shoots which had been kept in water for two days to induce further development of the buds. In order to allow easy penetration of the tissues by the fixing fluids, the bract, calyx, and top of the corolla were removed from the small buds, leaving the base of the corolla as a ring round the ovary bearing the epipetalous stamens. The larger ovaries were removed from the flower for fixation and were sometimes cut across, again to facilitate penetration.

Various fixatives were used, but acetic alcohol and Allen's modification of Bouin's fluid gave the most successful results on the whole. Merkel's fluid gave the best preparations of early prophase in the microspore mother-cell nuclei. The material was cleared in xylol and kept in changes of paraffin wax for 8–12 hours. In winter, wax of melting-point 48° C. was used, and in summer wax of melting-point 52° C. Sections were cut at 8 μ . Various combinations of stains were used, including Flemming's triple, Breinl, and Heidenhain's iron alum hæmatoxylin with or without counterstain.

The work was carried out at Royal Holloway College, and I would like to take this opportunity of thanking Miss Blackwell for her interest and criticism during the investigation.

THE OVARY AND OVULE DEVELOPMENT.

The Ovary.—The mature ovary is a one-celled capsule of two carpels. It is bent forwards and downwards away from the main axis, and the style is still more bent in the same direction (text-fig. 1, a). The style is terminal and simple, and the stigma capitate and two-lobed (text-fig. 1, b).

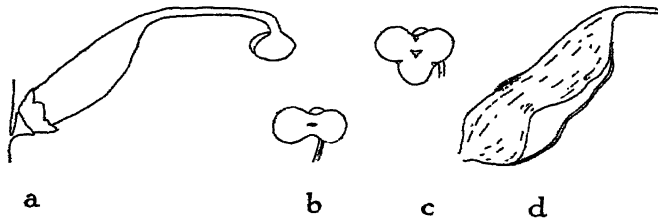


FIG. 1.

The placentas are four in number, distinct from one another or united in pairs, each containing a small vascular system (text-fig. 2, a). Placentation is parietal, the ovules numerous and anatropous, and the seeds minute. It is stated that there may be up to 1,500 seeds in a capsule (Boeshore (1920)).

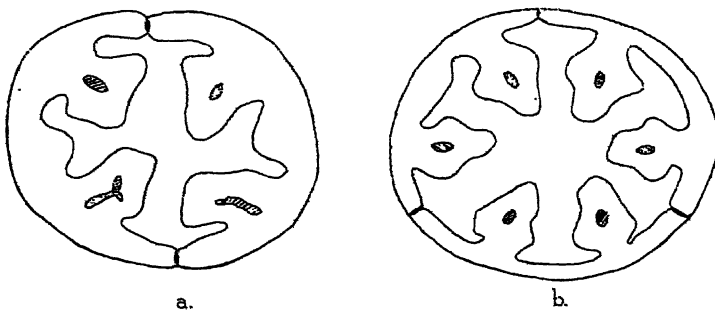
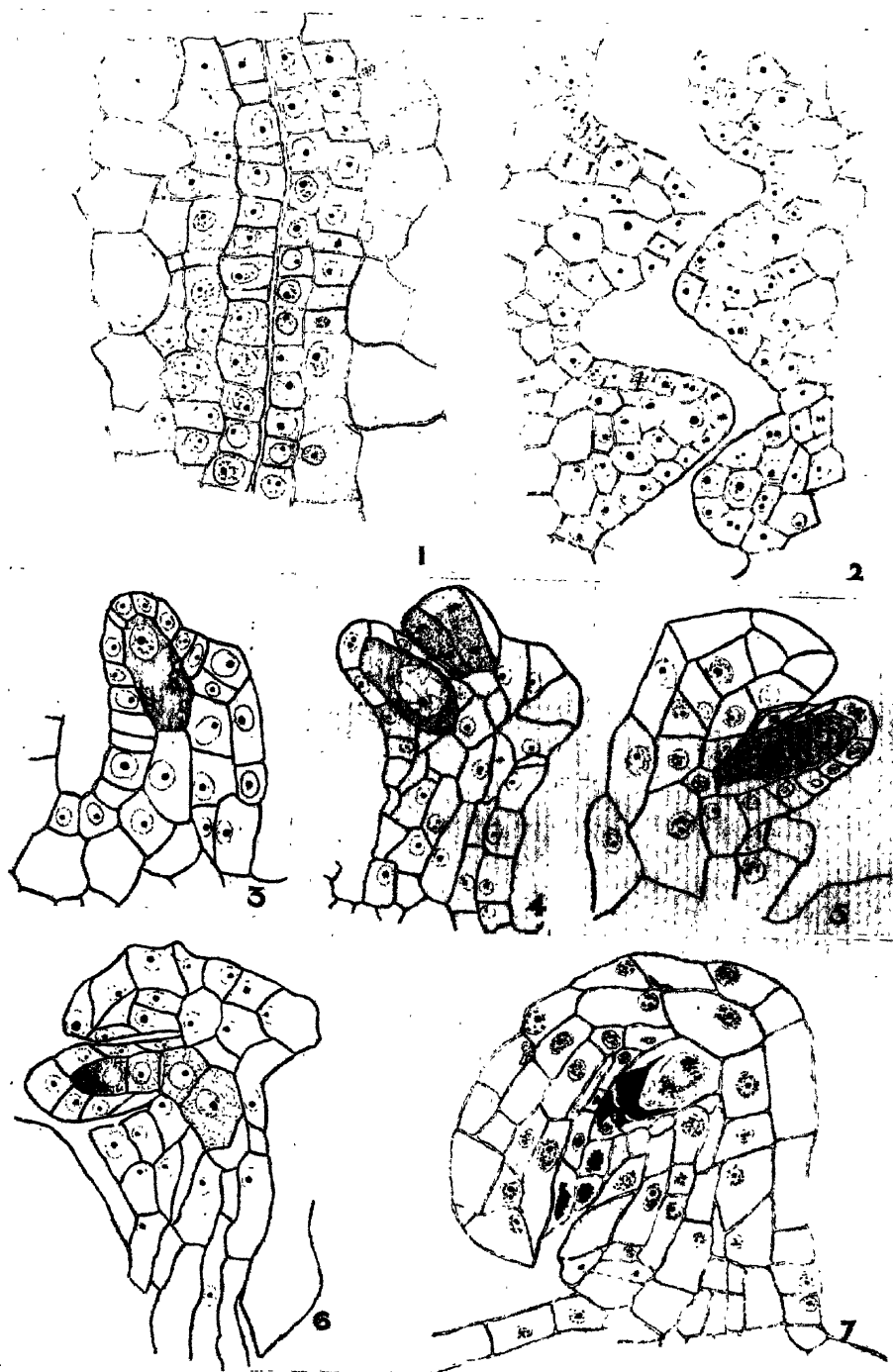


FIG. 2.

The stigma lobes change colour from yellowish-pink to bluish-pink as the flower opens, and mature to a dark brownish-purple, the typical colour of the species. The limits of the two carpels are indicated externally by two fine pigmented lines which run from between the stigmas to the base of the ovary. The ovary grows in length until from $\frac{1}{2}$ in. to $\frac{5}{8}$ in. long, and dehiscence is septicidal, the first break occurring along the anterior



pigmented line (text-fig. 1, d). A great many flowers have been examined in which there are three carpels, three stigmas, three pigmented lines and six placentas (text-figs. 1, c. 2, b). This third inserted carpel is anterior in position. These flowers occur in the same inflorescence as those with two carpels.

Development of Ovules.—The placentas preserve an even surface until the stamens, always in advance, have almost developed the microspore mother-cells. In section the placentas then begin to show a wavy outline. Before this the epidermis and hypodermis show differentiation (plate I, fig. 1). Their nuclei are larger and more spherical than those of the ground tissue, while the cytoplasm is less vacuolate and retains stains, such as Orange G, more readily. While the ovary has been increasing in length, the cells of these two layers have divided frequently, spindles being most plentiful in the plane of the length of the ovary. Cell division in these two layers now occurs more rapidly than is necessary for uniform growth of the ovary, and the surface of the placentas becomes uneven and bluntly papillate. The papillæ are soon recognised to be the ovules. The ovule initials appear to arise very close together, each as a group of epidermal and hypodermal cells, and the ovules are crowded (plate I, fig. 2). More frequently than not, a single hypodermal cell stands out clearly at this stage of differentiation of the ovule. Koch (1887) describes the divisions of this cell and states that they occur in a definite order. A detailed study of this stage has not been included in the present investigation. It has been observed, however, that the single hypodermal cell gives rise to a group of five or six cells, the outermost of which is the megaspore mother-cell. Thus the megaspore mother-cell lies immediately below the epidermis (plate I, fig. 3), in which the transverse walls are oblique. Schertz (1919) gives a similar figure for *Scrophularia marylandica*, and says: "While the megaspore mother-cell is being formed, a layer of nucellar tissue surrounds it," and "The cells of the nucellus are long and narrow and their transverse walls are usually oblique." The megaspore mother-cell does not divide to give a row of four megasporocytes until the cells of this portion of the epidermis have multiplied considerably, allowing elongation of the megaspore mother-cell (plate I, figs. 4-6).

Growth of Integumental Tissue.—During the growth of the megaspore mother-cell and its subsequent divisions, integumental tissue grows up. It appears that this tissue grows in one mass, and not in separate layers, as described in general for angiosperms; cell division occurs in all directions, causing growth in thickness as well as in length. Meanwhile the stalk of the ovule, which is always short, and the integument grow more rapidly on one side, turning the whole ovule sideways. Meiosis occurs when the long axis of the megaspore mother-cell runs approximately parallel to the placenta (plate I, figs. 5-6). Further growth occurs, and by the time the embryo sac is binucleate, it and the one-layered nucellus are surrounded by the integument, which is at least three, and usually

four or five, cells thick, and the whole structure has curved round so that the micropyle is close to the stalk and the ovule is anatropous (plate I, fig. 7). The single integument, several layers thick, is also found in *S. marylandica* (Schertz (1919)).

Degeneration of Functionless Megaspores and Development of Embryo Sac.—For some time after their formation the four megaspores are about equal in size and their nuclei are in a resting condition. After a certain period the chalazal megaspore begins to enlarge, while the remaining three become smaller and degenerate. They can usually be seen forming a cap on the functioning megaspore, when they appear in section as crescents

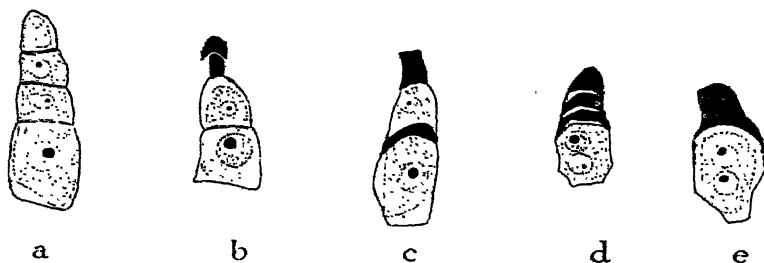


FIG. 3.

or triangles or a shapeless mass (text-fig. 3, a-e). Only rarely have they been seen after this stage. In a few cases it has been noticed that all three megaspores, other than the chalazal one, do not degenerate at once. One of the two middle megaspores may remain turgid for a while (text-fig. 3, b, c). In a few cases one of them has been seen slightly

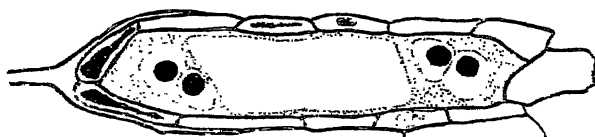
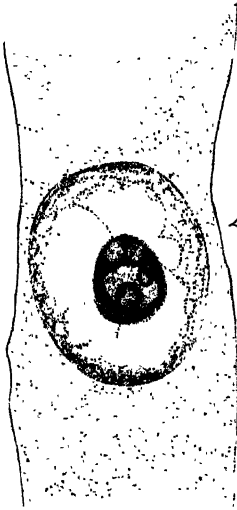


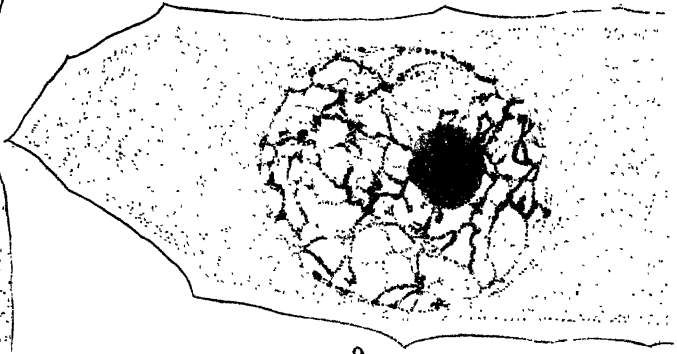
FIG. 4.

enlarged, and it is possible that rarely more than one embryo sac may be formed.

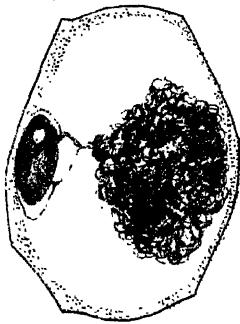
The chalazal megaspore now enlarges, and its nucleus divides to give two large nuclei, which rest for a time (plate VI, fig. 30, text-fig. 3, d, e). Soon the cytoplasm becomes vacuolate in the centre of the sac, and the two nuclei are forced one to either end of the sac with a vacuole between them. This may become larger and reach from side to side of the sac. The nuclei then divide again, simultaneously, on spindles which lie approximately at right angles to one another, giving a four-nucleate sac (text-fig. 4). Sometimes the central vacuole is absent until after this



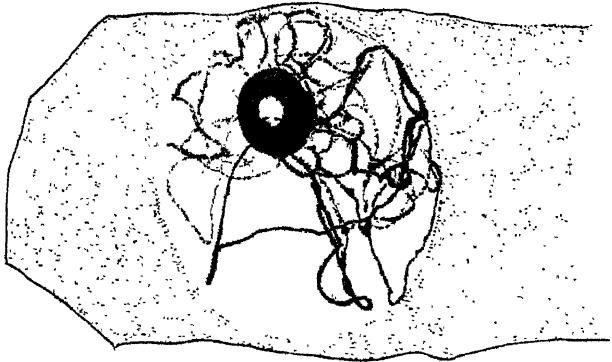
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12.



11



13

division. In the few instances of this division that have been seen, the dividing nuclei are indistinct and small compared with the one from which they arise.

The Mature Embryo Sac.—The next stage found is that of the eight-nucleate embryo sac. This is typical of angiosperms with egg and two synergids at the micropylar end of the sac, two large polar nuclei in the centre, and three antipodals at the chalazal end. The antipodals soon degenerate, and all sign of them has disappeared long before the time of fertilisation. The polars are large and lie close together in the centre of the sac, and may be separated from the egg apparatus by a vacuole. The five nuclei of the mature sac are in the resting condition, each with a single large nucleolus into which most of the chromatic material is collected.

THE STAMEN AND POLLEN DEVELOPMENT.

The Stamen.—The stamens are epipetalous, four in two pairs, with white filaments broad and flat towards the base, and dark anthers of the same colour as the stigma (text-fig. 5). The upper part of the filaments



FIG. 5.

is glabrous and the lower part is covered with stalked, glandular hairs. Similar hairs are found scattered on the ovary and in large numbers on the sepals, bracts, and stalk. The filament is curved as shown in the figure. Dehiscence is introse and occurs before the flower is fully open. The curvature of the style brings the stigma very close to the anthers, and self-pollination seems possible. The flowers are, however, protandrous, and germinating pollen has been observed on the still receptive stigmas of much older flowers. A young stamen examined in sections of the apex of the inflorescence shows as a small mass of undifferentiated tissue. Soon a very short filament appears, while the mass of tissue becomes lobed. This differentiation occurs at a very early stage in the development of the flower. The filament then grows in length and at the same time becomes curved, so that sections median to both anther and filament become more rare. Starch is abundant in the filament below the connective and also in the ovary walls.

Development of Tapetum and Pollen Grains.—The tissue of the anther is soon differentiated into wall, tapetum, and sporogenous tissue. The tapetal cells are radially elongate and uninucleate, and the unstained cytoplasm is dense and yellowish. Each nucleus is large, with one or two deeply staining nucleoli. Few nuclear divisions have been observed in these cells, but they are mitotic and give rise to binucleate cells before the microspore mother-cells are formed, and later each cell may have more than two nuclei. The tapetal cells between the sporogenous tissue and the connective begin to disorganise first. The anther wall now consists of two or three layers of cells formed by the tangential division of one layer.

The microspore mother-cells are large and closely packed together and angular by pressure. Each is turgid with dense cytoplasm and one large nucleus. During the prophase of the heterotype division extrusion of chromatin has been observed. The reduction divisions give rise to tetrads of microspores which, when very young, can be fixed by several reagents without shrinkage. At a later stage they tend to shrink. This is probably due to changes that have taken place in the permeability of the wall. The cell walls may be curved inwards after fixation, during or just after the separation of the microspores from the tetrad. Soon after this separation the individual pollen grains become spherical, and shrinkage is slight if it occurs at all. The cell is vacuolate, and the denser cytoplasm immediately around the nucleus is pressed to one side. The vacuole becomes smaller, and the nucleus takes up a central position and divides to give the tube and generative nuclei.

Degeneration of the Tapetum.—The binucleate tapetal cells have dense cytoplasm with no large vacuoles, and the nuclei are large and spherical, and contain generally one but sometimes two or three nucleoli. All the material which retains chromatin stains is collected in the nucleoli, and the stained nucleus appears clear and clean, in striking contrast with its appearance later. During or after the reduction division of the microspore mother-cells the tapetal cells are multinucleate, four being a common number of nuclei in each cell. Each of these nuclei has from four to seven nucleoli, and degeneration is general. The cytoplasm of fixed material is ragged, vacuolate, and contracted from the cell walls, and the nuclei are no longer spherical, but appear plasmolysed. They then decrease in size and tend to retain chromatin stains throughout. The cell walls break down, and when the pollen is binucleate the tapetal cells have almost disappeared.

MEIOSIS IN THE MEGASPORE MOTHER-CELL.

Resting Nucleus of Megaspore Mother-Cell.—It has already been stated that the megaspore mother-cell is differentiated early in the development of the ovule, and that the cell grows in length for a long time before the meiotic divisions occur. The nucleus is large, spherical or ellipsoidal, and

usually occupies the whole width of the cell. If it is ellipsoidal, the elongation is in the direction of the long axis of the cell. The resting nucleus presents a very faintly staining reticulum which has a cloudy, granular appearance, but, as the whole stains so faintly, it is difficult to make out any definite structure. The reticulum is chiefly peripheral, but extends inwards for some distance; it is absent except for a few threads from a clear zone which surrounds the nucleolus. The latter is large and spherical; it generally occupies the centre of the nucleus. Occasionally one or more small bodies are present near the nucleoli which stain in the same way and are possibly of the same nature. The nucleolus is vacuolate, and, like the reticulum, stains faintly. Within the largest vacuole a refractive body may be seen which varies somewhat in appearance. In some cases it looks like an oil drop, and in others appears crystalline. In synaptic stages a definite crystalline body is seen in a similar position (plate II, fig. 8).

Heterotype Prophase. Synizesis.—The beginning of the heterotype prophase is indicated by the reticulum retaining chromatin stains more readily than before. It stains uniformly throughout, although still somewhat faintly. A little later small granules of chromatin appear on the reticulum, which now begins to withdraw from the nuclear membrane (plate II, fig. 9). The mesh of the reticulum becomes larger and the thread thickens. At this stage two portions of thread can often be seen anastomosing at two or more points. Again, as the reticulum gives place to a spireme during the approaching contraction, one thread thicker than the other is often observed. The thicker thread is vacuolate and may pass into two thinner threads. This is interpreted as an indication of the coming together of the two half univalent threads as first described by Digby (1910) for *Galtonia*. The reticulum now leaves the periphery, condenses and contracts on to the nucleolus and forms a tight knot round it. Until the contraction is complete, the nucleolus does not stain deeply. In synizesis the nucleolus may be either central and spherical, or pressed against the membrane and lens-shaped. In material fixed in acetic alcohol and in Allen's modification of Bouin's fluid it is more commonly found in the latter position, and is so much pressed against the membrane that it causes a bulge outwards at the point of contact. In material fixed in Flemming's strong solution the nucleolus is in the former position. The thread often touches one side of the nucleolus only. The fixative appears to have a marked effect on the nucleus at this stage (plate II, fig. 10 (acetic alcohol), fig. 11 (Allen's Bouin's fluid)).

Open Spireme.—The knot found in synizesis now loosens and loops are thrown out from it. If the nucleolus is not already in contact with the membrane, it must now move towards it, as in the following stage it is seen, almost without exception, pressed against the membrane. The mass of thread may take up various positions. The knot may remain in contact with the nucleolus or it may move to the centre of the nucleus in one mass

(plate II, fig. 10). In the latter case it remains connected to the nucleolus by at least one loop or two threads. In either case loops are thrown out from the knot, which gradually loosens (plate II, fig. 11). The threads forming the loops vary in thickness, and if thick are single, and if thin are often in pairs. This is a further indication of the association of two half univalent threads. The thread becomes looped and coiled throughout the entire nuclear cavity, and the nucleolus again becomes central. A vacuole can still be seen within it. The thicker portions of thread are seen to be "split," or, better, double, in places along their length, and the whole thread appears to be continuous (plate II, fig. 12).

Second Contraction.—Further condensation of the thread follows, and it again becomes looped around the nucleolus (plate II, fig. 13). The loops vary in size, some stretching right across the nuclear cavity and round part of the periphery, while others are short and close to the nucleolus. The double nature of the thread can still be seen, and the thread varies considerably in thickness and is very irregular. The two arms of a loop are, in some cases, twisted round each other. The later phases of this contraction show, in general, fewer short loops round the nucleolus than do the earlier phases. The univalent thread breaks up while it is still looped about the nucleolus in the position occupied in second contraction (plate III, fig. 14). Soon the whole thread is segmented, and each segment is bent in the form of a V with attenuated ends. The segments are scattered throughout the nuclear cavity, and rapidly thicken and condense and give rise to pairs of chromosomes of varied form.

Diakinesis.—During the formation of these pairs the two arms of the V may remain apart, or they may become twisted round one another, or the free ends may meet, causing the bivalent to form a ring, or the two arms may break apart at the apex of the V, the two free chromosomes so formed lying parallel to one another (plate III, fig. 15). It is not always possible to trace the individual pairs in later phases, as they suffer still further contraction and change in shape.

From this stage onward the paired condition of the chromosomes is apparent, and both here and in later phases of diakinesis nineteen bivalents have frequently been counted. This chromosome number is of interest, as in the only count made in related forms, in two species of *Lathræa*, twenty-one bivalents were found (Gates and Latter (1927)). The chromosomes now shorten considerably and at the same time thicken and assume a lumpy appearance (plate III, fig. 16). The nucleus is still elongated in the direction of the long axis of the ovule, and in many longitudinal sections some bivalents are seen grouped thickly around the nucleolus, which is situated towards one end of the nucleus, while the remaining bivalents are scattered freely towards the other end of the nucleus (plate III, fig. 16). So far the nucleolus has remained large and usually stains readily. In de-stained preparations a clear region can be observed within it. This is ex-centric and contains



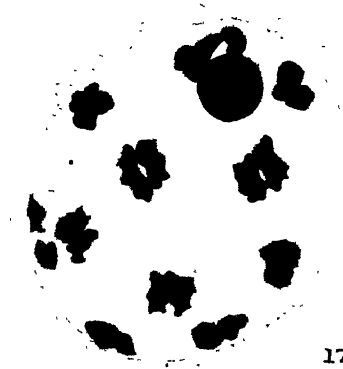
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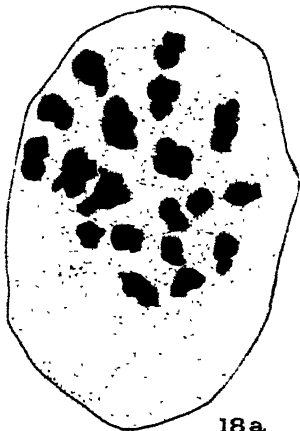
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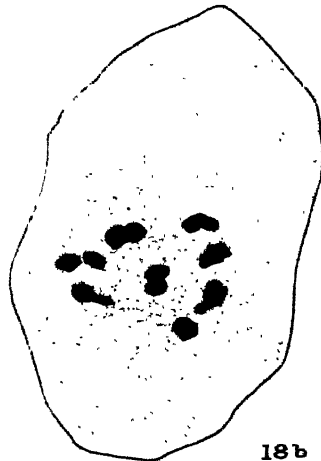
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17



18a



18b

refractive crystalline bodies. The nucleolus now becomes smaller and stains less readily until it is lost to view before metaphase.

In late diakinesis the bivalent chromosomes are scattered around the periphery of the nucleus (plate III, fig. 17). The short thick chromosomes often remain joined in their pairs by thin strands of stainable material. Some at least of these strands persist and form the bonds seen in metaphase and early anaphase. Here they become attenuated by the moving apart of the univalents until they finally break and appear to be drawn into the body of the chromosomes.

Metaphase.—The chromosomes become even more rounded and are arranged as a plate across the widest part of the spindle which generally occupies the whole width and about half the length of the megaspore mother-cell. The spindle is barrel-shaped with blunt rounded ends (plate IV, figs. 19, a. 20, a. 21). The chromosomes of a pair are difficult to distinguish until early anaphase, because in metaphase they lie close together. In preparations of a slightly later stage they can be seen forming a double plate. In surface view, when the plate is seen from the pole, the section being cut parallel to the plane of division, nineteen bivalents are seen. Where the section is not oblique, nineteen bivalents are seen at one focus, and the other nineteen come sharply and simultaneously into view when the focus is slightly changed. In fig. 18, a, an oblique section through a metaphase plate is shown. This contains ten bivalents and nine univalents. The remaining nine univalents—the pairs of these—are present in the next section, fig. 18, b. In many pairs the univalents are joined by one thick bond which makes the chromosomes appear continuous with one another, while in others they are joined by two distinct bonds. In either case the effect is to make the chromosomes appear tailed when viewed from the poles. Seen from the poles the chromosomes have a rounded outline, and their characteristic shapes cannot be recognised. Viewed from the side of the spindle several pairs of chromosomes are seen to be quite distinct in size and shape from the rest. This is much more marked in early anaphase.

Anaphase.—The univalents move apart as two plates in parallel planes. At an early stage the chromosomes of every pair still show one or two bonds between them, while later it is only the larger ones that show bonds, the smaller ones having already broken away from one another.

The chromosome shapes which appear again and again in nuclei fixed at this stage of division are as follows (plate IV, figs. 19 and 20). One bivalent is dumb-bell-shaped with each univalent pear-shaped and lopsided at the wider end. This displacement is in opposite directions, so that the resulting form is slightly S-shaped (text-fig. 6, a). Another bivalent is also composed of two pear-shaped univalents. Each of these has a slight constriction in the middle, and the lobe toward the pole is larger than the other. These univalents are also lopsided, but in the same direction (text-fig. 6, b). One or sometimes two bivalents are long and thin, and each

univalent is constricted at about the middle. These are not bent, and lie parallel to the axis of the spindle (text-fig. 6, c). In from four to six bivalents the univalents are held by a double bond. The univalents may be kidney-shaped (text-fig. 6, d), slightly three-lobed or elongated in the direction of the axis of the spindle. When these chromosomes move to the poles, one bond breaks before the other (text-fig. 6, e). These different and quite recognisable forms are seen well in early anaphase only, and their significance, if they signify anything, is not understood. The remainder of the nineteen bivalents, although distinct in shape, have not been so constantly observed and are therefore not described.

As the plates of univalents move apart and the bonds break, the chromosomes may appear "tailed" for a time, but soon the tails are withdrawn into the chromosomes, which become condensed and rounded or oval in outline. Their sizes then vary very little (plate IV, figs. 21 and 22). A polar view of anaphase plates nearing the poles is seen in plate IV, figs. 23, a, and 23, b, which show two sections through the same

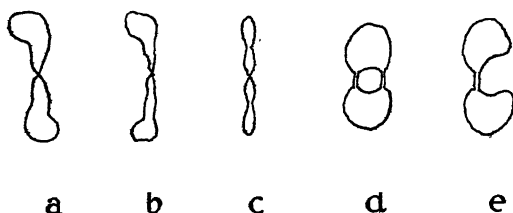
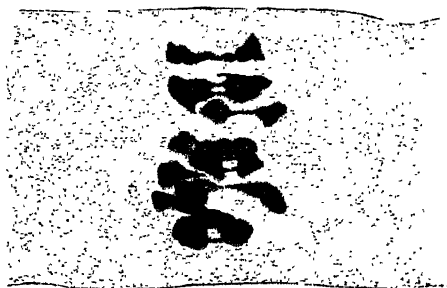


FIG. 6.

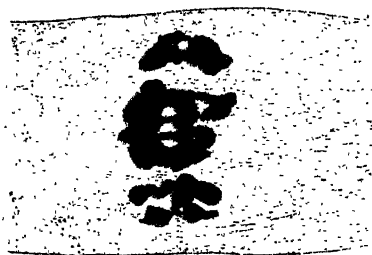
cell. Here the chromosomes have become angular, and connections appear to have been established between neighbouring ones (fig. 23, a).

Telophase.—As the chromosomes approach the poles of the spindle, those in the centre of the plate may be slightly in advance of the rest. They now move close together and form at the poles a dense mass in which individual chromosomes cannot be distinguished. As this mass loosens again, a nuclear membrane is formed round each daughter nucleus, and vacuoles appear within the mass of chromatic material. The spindle is still very distinct, and a wall is formed across the middle. As this wall becomes more defined, the spindle becomes less so until no sign of it remains.

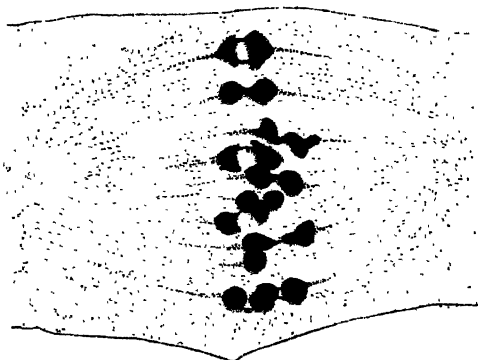
Interkinesis.—At interkinesis each nucleus is large, spherical, and clear, and shows a faintly stained, large-meshed, peripheral reticulum with the chromatin unevenly distributed upon it (plate V, fig. 24). There is one large nucleolus at one side of the nuclear cavity. This appears soon after the formation of the nuclear membrane. At first the nucleolus is difficult to distinguish, as it is as small as some of the chromatin masses and does not stain deeply, but later it is large and stains readily. In this interkinetic period no reticulum is formed, and the two nuclei pass quickly and simultaneously into the second or homotype division.



19a



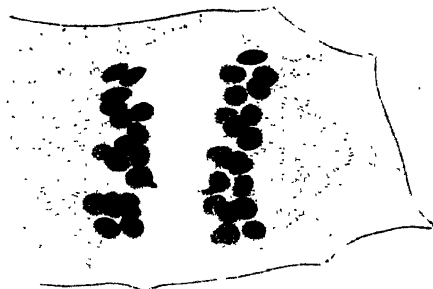
19b



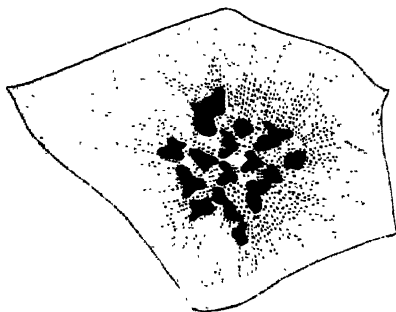
20a



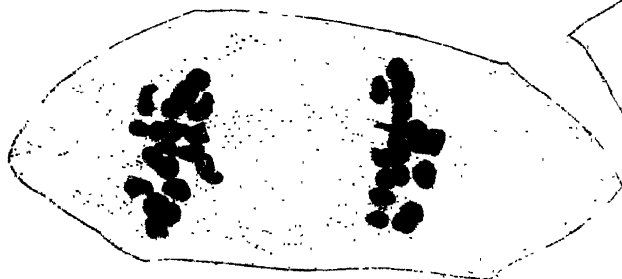
20b



21



23a



22



23b

The Homotype Division.—The prophases of this division are of short duration and the nuclei pass rapidly into metaphase. Earlier stages have not been observed, and the whole division is evidently very quickly passed through. The two spindles lie obliquely, making a large angle with one another. They are shorter and smaller altogether than in the heterotype division, and the chromosomes in metaphase are too close together for exact counts to be made, although it is clear that the haploid number is present. The chromosomes while on the metaphase plate are short and thick as in the previous division, but later, while travelling to the poles, are sometimes elongate and thinner, and then correspond more closely to those seen in somatic divisions of both diploid and haploid nuclei. The chromosomes pass to the poles and form a dense mass, and a cell wall is formed between each pair of the newly organised daughter nuclei. Nuclear membranes have developed, and the nuclei grow rapidly and nucleoli again appear. These become fairly large and stain rapidly, while the chromatin becomes spread out in small granules on a fine linin reticulum. The spindles become disorganised, and the resting stage of the four megaspores is reached (plate I, fig. 6). Sometimes one of the homotype divisions is slightly in advance of the other, and it is interesting to note that it is the inner one that is in advance. Similarly, one of the two daughter nuclei resulting from this division is sometimes in advance after telophase is reached and reorganisation begins. It is the nucleus nearest the base of the young ovule, and it has been shown that this is the megaspore which develops further and the only one which gives rise to an embryo sac.

Resting Megaspores.—The megaspores are easily recognised. The cytoplasm is dense in appearance, and spindle fibres persist in it until late telophase of the heterotype division. The nuclei become spherical as interkinesis is approached, and show a peripheral reticulum and one central nucleolus. The latter does not retain stains until the prophase of the next division. As the chromatin becomes more evenly distributed over the reticulum, the mass of material taking chromatin stains becomes less, and in the resting nucleus the reticulum is almost indistinguishable from the nuclear membrane.

MITOSIS IN THE EMBRYO SAC.

Prophase.—The chalazal megaspore increases in size, while the remaining three degenerate (text-fig. 3). The nucleus of the young embryo sac enlarges, and the linin is seen to be spread out in a thin, finely meshed peripheral reticulum forming a hollow sphere. The nucleolus, now usually in an ex-centric position, also enlarges and has a diameter approximately $\frac{3}{4}$ that of the whole nucleus. During the resting stage or early prophase the embryo sac is distinguished by its size, the dense mass of its cytoplasm, and the non-staining condition of the nucleus. The nuclei of the surrounding tissue always take up some chromatin stain. This is probably due to

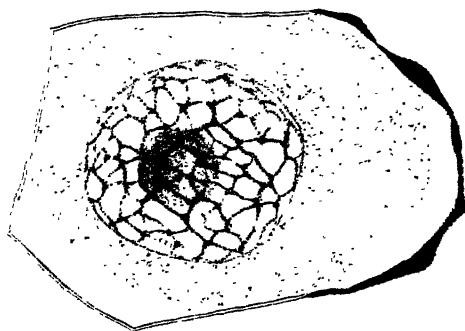
the fact that the embryo sac grows by the elongation of one cell, while the surrounding tissue grows by cell division to keep pace with it, and the nuclei therefore never have a resting stage. The cytoplasm of the sac becomes less dense as further growth occurs, until finally the central vacuole is formed. Prophase in the nucleus is indicated by a thickening of the reticulum, especially at the angles of the meshes. Both reticulum and nucleolus now retain chromatin stains (plate V, figs. 25, a, and 25, b). The reticulum gives place to a spireme which is discontinuous in all the cases found. It is not certain whether the whole spireme is ever one unbroken thread or if it is in several parts from the beginning, as the nuclei examined have nearly always been cut. It is clear, however, that the thread is in fewer pieces than the haploid number of chromosomes (plate V, fig. 26). The thread thickens, shortens, becomes less coiled and segments into nineteen chromosomes. Plate V, fig. 27, shows half a nucleus at this stage. The nucleolus now contains one to four vacuoles, often one large and two or three small ones.

Metaphase and Anaphase.—Very few instances have been seen of nuclei in stages between late prophase and late telophase, which points to a rapid completion of the division once prophase has ended. A few cases have, however, been noted. In every metaphase observed the chromosomes are close together and somewhat interwoven. This is probably because the stage seen is late metaphase, when a diploid number of daughter chromosomes are present and these are all long and thin (plate VI, fig. 28). The chromosomes move to the poles as long, narrow, straight or slightly curved rods. In this feature they are comparable with those seen in diploid somatic mitoses and differ from the short, thick chromosomes of the reduction divisions (plate VI, figs. 29, a, b). The chromosomes contract into a tight mass on reaching the poles of the spindle. The spindle occupies about half the length of the cell, and is not so broad as in the heterotype division. No sign of a wall forming between the two nuclei has been seen. A few deeply stained granules appear scattered in the cytoplasm; these may represent a fragmented nucleolus. The fate of the nucleolus has not been followed.

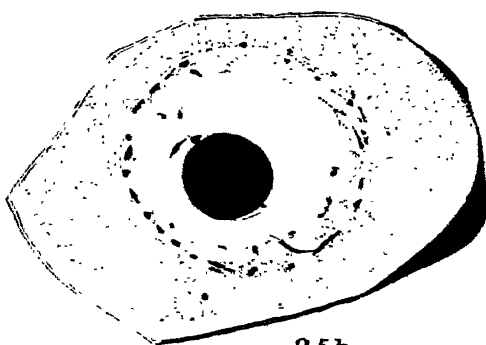
Telophase.—The chromosomes form a dense knot at each pole of the spindle, in which individual chromosomes cannot be recognised. When the knot loosens, anastomoses have appeared and the chromatin is spread out on a coarse network or reticulum. Meanwhile a nuclear membrane has appeared. The spindle begins to disappear when the daughter nuclei are each about half the size of the original mother nucleus. The chromatin becomes more evenly distributed on the reticulum as the nucleus enlarges, and a nucleolus appears. This becomes large and spherical and contains small vacuoles. The resting nuclei of the binucleate sac are similar to the nucleus of the uninucleate sac (plate VI, fig. 30). In most cases they almost fill the cell, and may be so large that they are pressed together and flattened against one another. The embryo sac continues to grow in



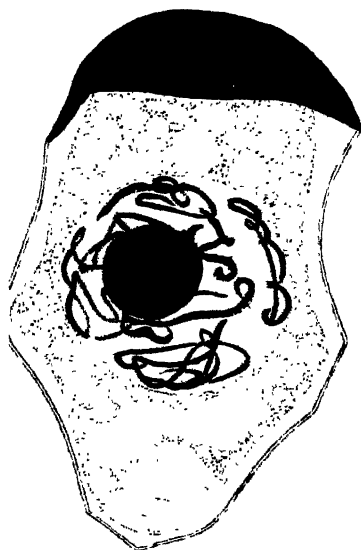
24



25a



25b



26



27

length and the cytoplasm becomes vacuolate. The two nuclei divide simultaneously to give a four-nucleate sac whose structure has already been described (text-fig. 4).

SUMMARY.

1. The megaspore mother-cell in *Orobancha minor* lies below one layer of nucellus and there is one integument.
2. The innermost megaspore forms the embryo sac, and the three others degenerate.
3. In meiotic prophase the reticulum becomes granular and withdraws from the membrane. In synizesis the knot of thread remains connected with the nucleolus, which presses against the membrane.
4. The nucleolus again becomes central, and the spireme coils through the nuclear cavity.
5. In second contraction the double nature of the thread is seen. While still looped, it segments into nineteen bivalents, which contract during diakinesis and form a double plate across a barrel-shaped spindle.
6. Several bivalents are of characteristic shape in early anaphase, but the univalents round off as they move apart.
7. The chromosomes in haploid divisions in the embryo sac are long and narrow. Their shape is a point of distinction between somatic and meiotic divisions.
8. The nuclei rest in the binucleate sac and almost fill it.

REFERENCES.

- BOESHORE. (1920).—"The Morphological Continuity of the Scrophulariaceae and Orobanchaceae." Contrib. to Bot. Lab., Univ. of Pennsylvania, 5, 139.
- DIGBY, L. (1910).—"The Somatic, Premeiotic, and Meiotic Nuclear Divisions of *Galtonia candicans*." Ann. Bot., 24, 737-57.
- GATES, R. R., and LATTEB, J. (1927).—"Observations on the Pollen Development of Two Species of *Lathraea*." J. R.M.S., 47, 209-25, pls. 6.
- KOOH, L. (1887).—"Die Entwicklungsgeschichte der Orobanchen." Dissertation.
- SCHERTZ, F. M. (1919).—"Early Development of Floral Organs and Embryonic Structures of *Scrophularia marylandica*." Botanical Gazette, 68, 441-50, pls. 3.

DESCRIPTION OF PLATES.

Note.—All the figures were drawn with the aid of a camera lucida, and the approximate magnifications are plate I 600 diameters and plates II-VI 3,400 diameters.

The following abbreviations are used for the names of fixatives and stains:—

Fixatives.

- A.—Absolute alcohol.
 Ac.A.—Acetic alcohol.
 Fs.—Flemming's strong solution.
 B.—Allen's modification of Bouin's fluid.
 M.—Merkel's fluid.

Stains.

- Ft.—Flemming's triple.
 Br.—Breinl.
 Hh.—Heidenhain's iron-alum hæmatoxylin.
 Hh. OrG.—The last counterstained with Orange G.

PLATE I.

Plate I shows the growth of the ovule and integument until the anatropous position is attained. The development of the megaspore mother-cell is also shown.

- Fig. 1.—L.S. of part of young ovary, showing two placentas. The epidermis and hypodermis are differentiated with nuclei larger and more spherical than those of the ground tissue, and with less vacuolate cytoplasm. (M., Br.)
- Fig. 2.—Section through young ovules, median to one only, showing that they are crowded. (A., Hh. OrG.)
- Figs. 3-7.—Almost median sections of single ovules showing development of integumental tissue and the sideways growth of the ovule.
- Figs. 3-6 show how the megaspore mother-cell and the products of its reduction division lie below one layer of nucellus in which the walls are oblique.
- Fig. 3.—An early stage; integumental tissue beginning to form. (B., Hh. OrG.)
- Fig. 4.—A little later stage than fig. 3. (B., Hh. OrG.)
- Fig. 5.—A still later stage, showing slight growth of integument on lower side of ovule. Interkinesis in megaspore mother-cell. (AcA., Hh.)
- Fig. 6.—Slightly oblique section showing four megaspores; the chalazal one is the largest. The plane of division has been approximately parallel to the placentas. (B., Hh. OrG.)
- Fig. 7.—Anatropous ovule with one integument several layers thick. Three degenerating megaspores form a cap on the young embryo sac, in which the nucleus is in late anaphase. (AcA., Hh.)

PLATE II.

All the figures of plate II and figs. 14-17 of plate III show prophases of the heterotype division of the megaspore mother-cell.

- Figs. 8, 9, 12, show longitudinal sections and figs. 10, 11, transverse sections of the cell, in which the relative size and shape of the nucleus may be noted.
- Fig. 8.—Resting nucleus with peripheral reticulum, leaving a clear space round the nucleolus, which is vacuolate and contains a refractive body. The whole stains faintly. (B., Hh. OrG.)
- Fig. 9.—Nucleus in early prophase, showing chromatic granules on the reticulum, which is withdrawing from the nuclear membrane. (AcA., Hh.)
- Figs. 10, 11, show late synizesis and the loosening of the thread from the knot.
- Fig. 10.—The knot of thread in a central position connected to the nucleolus by a loop. The nucleolus is pressed against the membrane and is lens-shaped. (AcA., Hh.)
- Fig. 11.—Loops thrown out across the nuclear cavity from the knot of thread, which is still in contact with the nucleolus. (B., Hh. OrG.)
- Fig. 12.—Nucleus in hollow spireme stage. The thread is continuous and is looped and coiled throughout the nuclear cavity, and in places is "split." (B., Hh. OrG.)
- Fig. 13.—Nucleus in second contraction. The thread is continuous and is shorter than before, and its double nature can be seen. (B., Hh.)

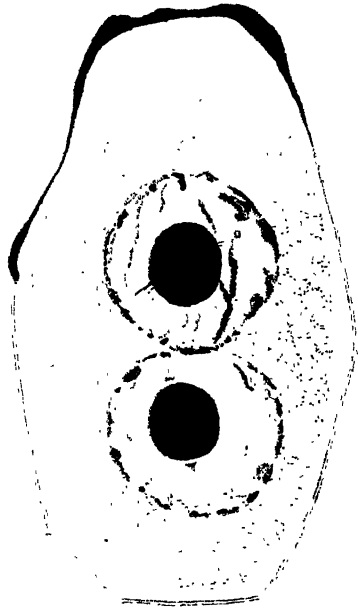
PLATE III.

Figs. 14-17 show the formation of the chromosomes and diakinesis.

- Fig. 14.—A stage very soon after that shown in fig. 13. The thread has segmented while looped about the nucleolus in much the position occupied in that figure. Nineteen segments can be seen, most of which are in the form of a V with twisted arms. (B., Hh. OrG.)
- Fig. 15.—A little later stage than fig. 14. Early diakinesis. The bivalents have condensed and assumed various shapes. (AcA., Hh.)
- Fig. 16.—Half nucleus showing shorter, thicker bivalents. (B., Hh. OrG.)
- Fig. 17.—Half nucleus in late diakinesis, showing twelve bivalents scattered round the periphery of the nucleus. The remaining seven are present in the next section. The nucleolus is shown. (B., Hh. OrG.)
- Figs. 18, a and b, are drawn from successive sections of the same nucleus.
- Fig. 18, a.—An oblique section showing view of equatorial plate. Ten bivalents are seen and nine univalents. (B., Br.)
- Fig. 18, b, shows the nine univalents corresponding to these. (B., Br.)



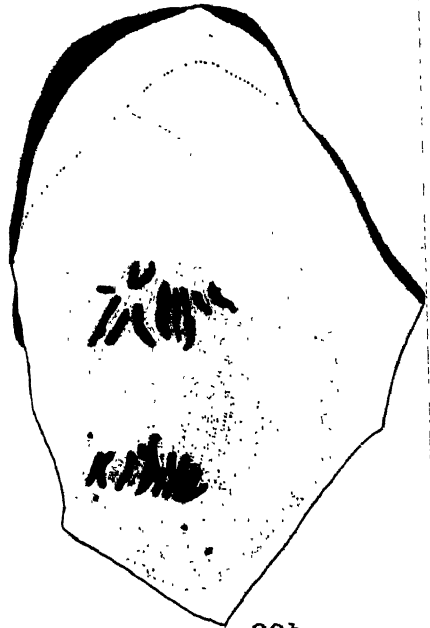
28



30



29 a.



29b

PLATE IV.

- Figs. 19, a and b are drawn from successive sections of the same nucleus. Each shows a half nucleus. Lateral view of equatorial plate in early anaphase. Characteristic chromosome shapes can be distinguished. There are nine pairs and a single chromosome in each figure. (AcA., Hh.)
- Figs. 20, a and b.—Two half nuclei from successive sections of the same nucleus. Ten bivalents and one univalent are present in 20, a, and eight bivalents and one univalent in 20, b. The shapes of the chromosomes are similar to those in the previous figures. The shape of the spindle can be seen in figs. 19, a, 20, a, and 21. (B., Hh. OrG.)
- Fig. 21.—Lateral view of anaphase plates, each containing nineteen univalents, now rounded or oval in outline and all much the same size. The spindle, now most condensed at the ends, can be seen quite clearly. (B., Hh. OrG.)
- Fig. 22.—Later anaphase. Two groups of nineteen chromosomes nearly at the poles. (B., Ft.)
- Fig. 23, a and b.—Corresponding anaphase plates from successive sections of one cell, in polar view. Each plate contains nineteen chromosomes. (B., Hh. OrG.)

PLATE V.

- Fig. 24.—Two daughter nuclei in interkinesis. In each is shown the nucleolus, and peripheral reticulum with chromatin unevenly distributed upon it. The spindle and new cell wall are shown, but the wall of the mother-cell has been omitted. (AcA., Hh.)
- Figs. 25–30.—Longitudinal sections of embryo sacs during first division of the nucleus. (AcA., Hh.). One degenerate megaspore can be seen as a crescent or cap on the embryo sac.
- Fig. 25, a.—Surface view of nucleus when the reticulum is just beginning to thicken at the corners of the meshes.
- Fig. 25, b.—The same nucleus focussed to show a median section. The reticulum is peripheral.
- Fig. 26.—Half nucleus showing spireme.
- Fig. 27.—Half nucleus at a later stage. Nineteen long narrow chromosomes have been formed. The nucleolus is still prominent.

PLATE VI.

- Fig. 28.—Lateral view of metaphase plate, when the daughter chromosomes are beginning to move apart. Fragments of chromatic material, possibly representing nucleolus, are scattered in the cytoplasm.
- Figs. 29, a and b.—Half nuclei in anaphase from adjacent sections of the same cell. The chromosomes of somatic divisions are long and narrow.
- Fig. 30.—A binucleate embryo sac with resting nuclei.

ABSTRACTS AND REVIEWS.

ZOOLOGY.

(Under the direction of G. M. FINDLAY, M.D.)

STAINING AND IMPREGNATION METHODS.

Certain Factors Influencing the Staining Properties of Fluorescein Derivatives.—H. J. CONN and W. C. HOLMES (*Stain Technol.*, 1928, 3, 94-104). Fluorescein dyes, such as eosin, erythrosin, phloxine and rose bengal, are ordinarily purchased in the form of di-sodium salts and are indifferent agents for staining bacteria in dried films of soil. If to the dye solution a small amount (0.001 to 0.1 p.c.) of a mineral salt of calcium, aluminium, magnesium or lead be added, the intensity of staining is greatly increased. This is due to the conversion of the dye partly into a salt of the metal added, which in nearly every case is relatively insoluble, and is in every case less soluble than the di-sodium salt. Practically identical results can be obtained if the staining be performed with a suspension of the calcium, aluminium, or lead salts of one of these dyes, although very little of the dye goes into solution.
G. M. F.

The Replacing of Formol in Histological Technique.—A. CRETIN ("Le remplacement du formol en technique histologique," *Arch. de Biol.*, 1928, 38, 87-92). A saturated solution of sodium fluoride can be used in most fixing mixtures instead of formalin, most of the well-known disadvantages of formaldehyde being avoided.
G. M. F.

Rapid Method of Triple Staining.—M. HUBIN ("Un procédé rapide de triple coloration," *Arch. de Biol.*, 1928, 38, 23-29). The tissues are fixed in a modified Hollande's fluid, frequently followed by Bouin's fluid. Sections are stained with Carazzi's acid hæmatoxylin, blued in tap water, brought to 70 p.c. alcohol and then stained in an alcoholic solution containing safranin (Merck), eosin A.G. (Grübler), and gold orange (Grübler). After rapid differentiation in acid alcohol the sections are dehydrated, cleared in xylol, and mounted in the usual way.
G. M. F.

Cultural Separation of Bacteria on the Basis of Triphenylmethane Co-efficients.—J. W. CHURCHMAN and L. SIEGEL (*Stain Technol.*, 1928, 3, 73-80). The resistance to crystal violet of five Gram positive and five Gram negative organisms has been determined. Gram positive organisms are much less resistant to the action of triphenylmethane co-efficients than Gram negative organisms, but each species has a definite resisting power which is specific for the species.
G. M. F.

The Effect of the Chemical Nature of a Decolorizer on its Functioning.

I. The Gram Classification.—A. E. STEARN and E. W. STEARN (*Stain Technol.*, 1928, 3, 81–6). Decolourisers which are distinctly acidic or basic in their chemical nature give abnormally high decolorisation in the Gram stain for bacteria. Acidic substances yield more regular results. Ideally an “inert” decolouriser should be used, but ordinarily such substances will not dissolve the dye or dye-mordant precipitate from the smear. The most practical, substances seem to be those so very slightly acidic in character as to be practically inert, such as acetone or alcohol, or a mixture of such substances.

G. M. F.

II. The Apparent Isoelectric Point.—E. W. STEARN and A. E. STEARN (*Stain Technol.*, 1928, 3, 87–93). The isoelectric point of a bacterial system is the hydrogen-ion concentration at which there is equal retention of anion and cation. Defining this point as that at which there is equal retention of acidic and basic stain when acetone is used as a decolouriser, it is shown that acidic decolourisers shift the experimentally determined point to a higher *pH* value, while basic decolourisers shift it to a lower value. Thus basic decolourisers show abnormally high decolourising power towards smears stained with acid dyes, and acid decolourisers show the same abnormal behaviour towards smears stained with basic dyes. By basic decolouriser is meant, not one of high *pH* value, but one which will form a salt with acids, as, for example, pyridin or anilin. This indicates an ionic chemical equilibrium as a factor in the mechanism of staining.

G. M. F.

Vital Staining of Normal and Malignant Cells.—R. J. LUDFORD (“Vital Staining with Trypan Blue and the Cytoplasmic Inclusions of Liver and Kidney Cells,” *Proc. Roy. Soc., B.*, 1928, 103, 288–301, 19 text-figs.). In the cells of the kidney and liver of animals stained intravitaly with trypan blue dye droplets, mitochondria and Golgi apparatus can all be distinguished. No definite relationship can be established between dye droplets and mitochondria, but the dye droplets make their appearance in relation to the Golgi apparatus and, when formed, break away from it into the cytoplasm, thus resembling the process of formation of secretion granules in gland cells.

G. M. F.

GENERAL CYTOLOGY.

Mitochondria in the Living Cell.—E. S. HORNING (“Studies on the Behaviour of Mitochondria Within the Living Cell,” *Austral. J. Exp. Biol. & Med. Sci.*, 1928, 5, 143–8, 1 pl.). Observations have been made on the behaviour of mitochondria in the living cell of *Heterotricha* where they are observed to be undergoing active Brownian movement. Denser aggregations of mitochondria are present in the region of the meganucleus and the food vacuoles. This effect may be due to a surface tension phenomenon, dependent upon their phosphatidal nature. Mitochondria were also observed within the food vacuoles of the living organisms due to an adhesion to the engulfed food circulating within the protoplasm of the living cell. Finally a vacuole is secreted around the food, together with its adhering mitochondria. They appear to be unable to penetrate the vacuolar membrane. The presence of mitochondria within the food vacuoles of the *Heterotricha* is regarded as a direct demonstration of the origin of digestive enzymes from mitochondria.

G. M. F.

The Influence of Oxygen Tension upon the Respiration of Unicellular Organisms.—W. R. AMBERSON (*Biol. Bull.*, 1928, 45, 79–91, 1 text-fig.). By standard methods of gas analysis the respiratory exchanges of *Paramecium* and of fertilised *Arbacia* eggs have been studied. The respiratory rate in both materials is found to be practically constant over a wide range of oxygen tensions, thus confirming older work done by other methods. In the fertilised *Arbacia* egg the oxygen consumption is practically constant between 228 and 20 mm. Hg. partial pressure of oxygen. Between 80 and 20 mm. Hg. there is a diminution in oxygen intake, but at 20 mm. Hg. the consumption is still about 90 p.c. of that at atmospheric pressure. Below 20 mm. Hg. the consumption is sharply reduced. The cleavage of *Arbacia* eggs proceeds at a normal rate down to very low oxygen tensions. No retardation in development has been observed above 11 mm. Hg. Below this value the rate becomes slower, and cleavage ceases entirely below 4 mm. Hg. G. M. F.

Cytological Studies of Hydra.—E. WERMEL ("Zytologische Studien au Hydra," *Zeitschr. Zellforsch. u. Mikrosk. Anat.*, 1926, 4, 227–36, 1 pl., 1 text-fig.). Chiefly a microchemical study of *Pelmatohydra oligactis*. The effects of several technical methods are described in detail. The somatic chromosome number is either 12 or 14. Mitoses are most abundant in interstitial cells, and in general show no peculiarities. By a modification of the Feulgen-Rossenbeck method (the use of light green instead of eosin), differentiation of thymonucleic acid was accomplished. Formation of reserve albumen granules in the entoderm cells is ascribed to transformation of nuclear material, deposited about the nucleus as nucleoproteid, the proteid nature being shown by the Ehrlich diazoreaction. A fatty substance envelopes the granules by progressive steps. The "pseudo cells" of the egg are said to be interstitial cells changed by cytoplasmic glycogen formation and probably are protein modifications of the nucleus. These changes and the formation of protein granules in the entoderm nucleus are regarded as true physiologic degeneration. No passage of chromatin ("Chromatinaustritt") into the cytoplasm has been observed. Comparative notes on results of other workers and a bibliography are included. The figures are in colour. *Biological Abstracts.*

New Researches on Human Spermatogenesis.—H. DE WINIWARTER and K. OGUMA ("Nouvelles recherches sur la spermatogenèse humaine," *Arch. Biol.*, 1926, 36, 99–166, 3 pls.). Material: Small pieces of fresh normal testes from individuals 19–23 years of age (surgical cases) were fixed in Flemming's fluid and stained with Flemming's triple stain or iron hæmatoxylin. Numerous spermatogonial equatorial plates have always given a count of 47 chromosomes (in accordance with the previous investigations of Winiwarter and, independently, those of Oguma and Kihara). By a rather complicated graphic technique it was possible to identify the X, or heterochromosome; this is single, its parts forming a horseshoe, but is not always the largest element. The authors have been unable to find the small element described by Painter as the Y-chromosome. In polar views of diasters (though complete counts were scarcely possible) the count always yielded more than 40 chromosomes in each daughter plate, showing that the count of 47 is not due to a splitting and separation of two halves of a chromosome during the metaphase, otherwise less than half this number should be found in the daughter cells. The modifications of the heterochromosome during the growth period were followed. When it becomes visible in the first spermatocyte (following the spermatogonial telophase) it is no longer horseshoe-like with the two arms approximately equal, but is a thick and elongated body. Its dimensions gradually increase; when the nucleus is at its largest, the heterochromosome is a large ovoid body. After this

stage its size gradually decreases until in the metaphase of the first spermatocyte it is a comma-like curved rod, one extremity of which is short and thick, the other long and slender. It sometimes shows a split which most often disappears before the metaphase. The first spermatocyte metaphase shows 10 large chromosomes in the form of more or less complete rings, 13 smaller elements, and the comma-like heterochromosome, a total of 24. The figures in profile show a very large and a very small chromosome, the two extremes (in size) of the spermatogonial chromosomes. One of the larger elements is distinguished by a precocious splitting and rotation of its halves in division. From this process figures result which appear at first sight as bivalent chromosomes, the two parts of which are unequal. Such figures could also be the artificial result of the section cutting. Certain figures by Painter correspond, perhaps, to effects of this character. In all cases diasters of the first division showed the heterochromosome undivided at one of the poles; secondary spermatocytes result with either 23 or 24 chromosomes. Winiwarter observed this fact in 1912 without being able to identify the heterochromosome. Metaphases of secondary spermatocytes corroborate this, and at this stage the heterochromosome has been recognised in half of the cells, when it participates in the division. The human species then is characterised by the formula $X-O$ in the ♂ (46 autosomes + 1 heterochromosome) and $X-X$ in the ♀ (46 + 2X). The paper concludes with a critical review of the work of other cytologists, whose different results are attributed to defective material, inadequate fixation, and often to imperfect technique. It is suggested that the observations of Evans and of Painter, who give 48 as the number for both ♂ and ♀, are correct, and are the expression of a variation in human races as to the presence or absence of the Y-chromosome. Nevertheless, as the authors are the only investigators who have followed the complete course of spermatogenesis, including metaphases and anaphases of the secondary spermatocytes (omitted, by others, because of lack of material), and have followed the heterochromosome in all of its stages, their researches are claimed to possess a degree of certitude not attained by their predecessors.

Biological Abstracts.

Origin of Female Germ Cells in the Rat and the Chromatic Processes involved during their Development to the Synapsis Stage.—W. RAUH ("Ursprung der weiblichen Keimzellen und die chromatischen Vorgänge bis zur Entwicklung des Synapsisstadiums. Beobachtet an der Ratte *Mus. decum. alb.*," *Zeitschr. Ges. Anat.*, 1926, 78, 637–68, 57 text-figs.). The paper describes in detail the mitoses and history of the primordial germ cells beginning with the 13-day embryo, where the primordial cells are present in the germ wall of the genital gland, and continues through the 17th day of development. From 13 to 14½ days the gonad develops into a distinct organ, easily distinguishable by the 15th day as to sex. During the 15th and 16th days the primordial germ cells in the ovary give rise to oogonia. These are abundant in the gonad of the 16½-day embryo. A brief period of rest then follows, which terminates during the 17th day in nuclear changes resulting in the formation of oocytes. In the nuclei of these, leptotene and synaptic phenomena are beginning. In the 15-day embryos division of the cells of the germinal epithelium is taking place. This is distinguishable from the mitoses occurring in the primordial germ cells, and always gives rise to epithelial cells. The chondriosomes in the cytoplasm of the germ cells are granular, while those in the cytoplasm of the germinal epithelial cells are of a short thread-like nature. This work, together with his earlier work on the ♂ germ cells of the rat, has led the author to make this summarising sentence: The primordial genital cells are the origin of the ♂ and ♀ germ cells.

Biological Abstracts.

Spermatogenesis in *Ranatra linearis*.—I. STEPOE ("La spermatogénèse chez *Ranatra linearis*," *Compt. rend. Soc. de Biol.*, 1927, 96, 1030-1). In specimens of this hemipteran, gathered near Bucharest in August and September, 43 is the constant number of spermatogonial chromosomes, all of similar form and size except five, which are much smaller. In the first spermatocytes 24 chromosomes appear; 19 are bivalent euchromosomes, but the five small ones remain univalent, one of which is larger than the other four. The first maturation division yields 24 chromosomes; in the second division the 19 euchromosomes divide equationally, while the other five form two groups, one consisting of the four smaller ones and the other of the one larger chromosome. These two groups always go to opposite poles, producing spermatids of $19 + 1$ and $19 + 4$ chromosomes. The author reported the same conditions in 1925 for *Nepa cineria*. Chickering in 1918 is quoted as reporting in the American *R. linearis* 40 (including an X-Y), but in autumn specimens 48-50 spermatogonial chromosomes. *Biological Abstracts*.

VERTEBRATA.

Histology.

Lesions in the Lining of the Mouth and Tongue in Rabid Dogs.—Y. MANOUÉLIAN and J. VIALA ("Lésions des parois de la bouche et de la langue chez les chiens enragés," *Compt. Rend. de l'Acad. des Sc.*, 1928, 186, 1242-3). Although to the naked eye the epithelial covering of the tongue and interior of the mouth may present no lesion, microscopically there are minute abscesses near to which are to be found ganglion cells containing Negri bodies. G. M. F.

Croonian Lecture: Certain Problems in the Physiology of the Cerebral Hemispheres.—I. P. PAVLOV (*Proc. Roy. Soc., B*, 1928, 103, 97-110). The cortex of the hemispheres constitutes an isolated afferent area of the central nervous system, where higher analysis and synthesis of inflowing excitations takes place, and from which combinations of excitation and inhibition flow out to the efferent areas. Observing the conditioned reflexes evoked, experiments were carried out on dogs, using conditioned alimentary, auditory, and tactile stimuli, with variation of strength, frequency, and time. The response of given cortical areas to definite stimuli points to a mosaic cortical structure, whose extirpation reveals reserve areas dispersed throughout the cortex, but incapable of reaching such functional perfection. The limit of excitability in response to a strong stimulus (or to summated weak stimuli) immediately precedes a state of cortical inhibition, which irradiates over the cortex, causing corresponding variation in subsequent reflexes. Individual differences in experimental dogs in their response to constant stimuli points to their being of three types—excitable, inhibitable and central, or well-balanced. This is comparable to temperamental variations in man, and dependent on the type of cortical activity. M. K. D.

Efferent Ducts of the Testis in Cat, Rat, and Mouse.—J. T. CUNNINGHAM ("On Ligature of the vas deferens in the Cat and Researches on the Efferent Ducts of the Testis in Cat, Rat, and Mouse," *Brit. J. Exp. Biol.*, 1928, 6, 12-25, 1 pl., 1 text-fig.). In rodents the inguinal canal is represented by a wide opening, and the testis can be retracted into the abdomen. In the cat and other carnivora the inguinal canal is open but narrow, and retraction is not possible. Vasectomy was performed on a cat, which was killed 104 days after the operation. Anatomical and microscopical examination of the testis of the operated side showed perfectly normal spermatogenesis. In the rat and mouse the epididymis is connected with

the testis by a membrane of some width, in which the vasa efferentia are contained, and a ligature can be passed round them. In the cat the epididymis is closely attached to the testis, and the vasa cannot be separately ligatured. Ligature of the vasa efferentia is always followed by disorganisation of the seminal epithelium and cessation of spermatogenesis. After the ligature of the marginal membrane in the majority of cases, normal spermatogenesis continued; in a minority the seminal epithelium was disorganised.

G. M. F.

Embryology, Evolution, Heredity, etc.

The Gonads of the Mouse.—F. W. R. BRAMBELL ("The Development and Morphology of the Gonads of the Mouse. III. The Growth of the Follicles," *Proc. Roy. Soc., B*, 1928, 103, 258-71). During the growth stage the diameter of the nucleus bears a direct relation to the diameter of the oocyte, while the diameter of the oocyte bears a direct relation to the diameter of the follicle during the growth of the former. The oocyte attains its maximum size of $70\ \mu$ in diameter when the follicle is $125\ \mu$ in diameter. The main growth of the follicle and the formation of the theca interna and the antrum take place after the oocyte has completed its growth. Fertilised ova only average $56\ \mu$ in diameter. The follicle grows rapidly, chiefly by enlargement of the liquor-filled antrum, during the two days immediately prior to the oestrous period and presumably in response to the production of oestrin. Ovulation takes place during late pro-oestrus or early oestrus. The average number of follicles maturing at each oestrous period is 9.3.

G. M. F.

A New Type of Mammalian Intersexuality.—J. R. BAKER (*Brit. J. Exp. Biol.*, 1928, 6, 56-63, 1 pl., 5 text-figs.). In certain islands of the New Hebrides a considerable proportion of the pigs are intersexual. Nowhere in the world are intersexual mammals so abundant. These intersexes differ from the rare intersexes of European pigs in the invariable absence of any rudiment of uterus or vagina. A tendency to intersexuality is inherited. The intersexes are interpreted as genetic males in which the testicular hormone has been produced too late in development.

G. M. F.

Studies on the Relation of Gonadic Structure to Plumage Characterisation in the Domestic Fowl. IV. Gonad Cross-Transplantation in Leghorn and Campine.—A. W. GREENWOOD (*Proc. Roy. Soc., B*, 1928, 103, 73-81). Testes from four hen-feathered, twelve-day-old Campine chicks were successfully implanted into four castrated brown Leghorn males of the same age. Normal male head-furnishings and characteristics were maintained in the host for 18 months. There was no alteration in the plumage character from cock to hen feathering. The result supports Roxa's conclusion that hen feathering of the male in a hen-feathered breed does not depend on an endocrine difference between the two kinds of testes. One testis from a white Leghorn chick, aged five weeks, was subcutaneously implanted into a hen-feathered two-year-old Campine capon, which displayed the typical cocky plumage and head-furnishings of the gonadless bird. Head-furnishings developed to one-third of normal size. No structural modification of the feathers was induced. Since the graft was of insufficient size to induce normal head-furnishings, the failure to change the feathering to the "henny" type may have been due to the small amount of testicular material used.

M. K. D.

Physiology of Ovarian Activity.—A. S. PARKES (*Biol. Rev. and Biol. Proc. Cambridge Philosoph. Soc.*, 1928, 3, 208-60). While in most mammals ovulation is spontaneous at oestrus, the length of aneustrous periods varying according to species; in rat and mouse ovulation occurs only after stimulus of copulation,

and corpora lutea do not become functional in the unmated animal. The age at which puberty is attained is constant in each species. Injection of ovarian extract causes the immature uterus and vagina to show oestrous symptoms abruptly; ovariectomised mice react incompletely to such injection. Daily injection of anterior pituitary extract hastens the appearance of oestrus in the immature mouse, but not in the ovariectomised animal (Smith and Engle, 1927). The oestrus-producing hormone (oestrin) has been isolated from placenta, liquor amnii, and foetal membranes. For experimental purposes a lipoid extract from liquor folliculi is used and injected subcutaneously (Allen and Doisy, 1923). Continued injection produced prolonged oestrus symptoms (detected by vaginal smear technique after 40-48 hours), but no post-ovulatory nor pseudo-pregnant phenomena. Mammary growth associated with puberty was accelerated, and increased growth and activity were observed in ovariectomised rats. There was no effect on the male animal, and no evidence of definite clinical bearing. In non-ovulating *Macacus* (Allen, 1927) oestrin injections do not replace corpus luteum, confirming the view that menstruation is pre-oestrous. Oestrin apparently is equally present in ovarian stroma and follicles. The work of Long and Evans (1922) suggests that the oestrous stimulus produces follicular maturation. Working with immature ovarian grafts in both sexes, Lipschütz (1925-26) demonstrates an external factor for gonad maturation, periodicity being only evident in the female; the rôle of the anterior pituitary in this connection is exhibited by the work of Smith and Engle (1927). Persistence of the corpus luteum is associated with absence of oestrus in the regular polyoestrous animal. Using an acetone precipitated ether extract of corpus luteum ground in anhydrous sodium sulphate, Parkes and Bellerby (1927) suppressed oestrus in mouse. The inhibition of oestrus produced by lactation disappears in the subsequently ovariectomised mouse. Oestrin injected into lactating mice produces oestrous symptoms varying in intensity with the number suckling. Persistent corpus luteum in rabbit (which normally shows no marked post-ovulatory growth) is accompanied by increased sensitivity of the uterus to mechanical irritation. This sensitivity (which is specific to the uterus, and equally evident in grafted uterine tissue) is inhibited by removal of both ovaries or of corpora lutea only. Negative results were obtained with extract of corpus luteum. In rat and mouse the corpus luteum of the unmated animal has neither a sensitising nor an oestrus-inhibiting function (Loeb, 1910). Removal of the corpus luteum in mouse interrupts pregnancy at any period. Knaus (1927) opines that the corpus luteum diminishes uterine sensitivity to pituitrin, which sensitivity returns to normal when the corpus luteum atrophies, thus partly confirming the hypothesis of Dixon and Marshall (1924) that the immediately pre-partum ovary stimulates the posterior pituitary lobe. Mammary tissue hypertrophies during the luteal phase of the ordinary cycle in the unmated guinea-pig, the hypertrophy being exaggerated when corpus luteum becomes persistent (as after hysterectomy). The lutealising effect of anterior pituitary on the ovary is accompanied by increased mammary growth in the unmated (non-ovulating) rabbit. Some product of conception would appear necessary for complete mammary development.

M. K. D.

INVERTEBRATA.

Mollusca.

The Regional Distribution of Australian Chitons (Polyplacophora).—E. ASHBY (*Rept. Australasian Assoc. Adv. Sci.*, 1926, 17, 366-93, 1 map). Distribution is discussed under three headings: (1) ecological: character of the rocks and

particular conditions favourable for development; (2) geological: effect of the breaking down of the Bassian Isthmus; (3) influence of ocean currents. (1) Given a fairly smooth, hard surface, with rocks that weather with fairly flat faces and which are piled one upon another below low water level, provided all other conditions are favourable, the number of examples and species will be in excess. (2) The breaking down of the Isthmus has had less to do with faunal distribution than one would have expected. (3) A map shows the direction, flow and area of impingement on the coast of Australia of the various ocean currents. The names proposed by Hedley for the marine faunal regions are accepted with the exception of the Solanderian, which it is proposed to suppress. Two new faunal regions are proposed: Indo-Australian, recognising the influence of a warm current impinging on the western coast from the Indian Ocean, and a Tasmanian region, the fauna of which gives evidence of a distinct Antarctic influence. A table lists the 135 known Australian species of chitons, with range of habitat. The apparent influence of changed thermal conditions on mutations of species is commented upon, and the hypothesis is propounded that the widely extended range of a, very limited number of species may be due to a prolonged pelagic stage, permitting of more extended transference by ocean currents.

Biological Abstracts.

The Oysters of the Roumanian Coast of the Black Sea.—I. BORCEA ("Note sur les huîtres du littoral roumain de la mer noire," *Ann. Sci. Univ. Jassy*, 1926, 14, 111–28, 2 pls.). The oysters of the Black Sea are described as follows: *Ostrea taurica* Kry., *O. sublamellosa* Mil., and *O. sublamellosa* var. *rumanica*. The author finds no evidence of identity between *O. taurica* and two species formerly assigned to this region, *O. adriatica* and *O. edulis*. In view of the facts that oysters grown in waters 20–30 p.c. salinity possess a better flavour than those grown in more saline water, and that 17 p.c. is the minimum at which oysters grow, he states that the waters along the Roumanian coast (salinity varying from 18 p.c. at the surface to 23 p.c. on the bottom) are perfectly suitable for oyster culture, especially of *O. taurica*, on a commercial scale.

Biological Abstracts.

Observations on Limpets.—H. BOULANGÉ ("Encore quelques observations sur les patelles (*Patella vulgata* L., *Helcion pellucidum* L.)," *Ann. Soc. Sci. Bruxelles*, 1926, 45, 313–15). The author records observations on the manner in which these limpets excavate a "home" or depression in soft rocks or in the stipe of an alga-like *Laminaria flexicaulis*. The type of hollow indicates but a feeble power of excavation. The action of the radula produces a very characteristic mark with curved lines 9–15 mm. wide and sometimes of appreciable though irregular extent. This, however, bears no resemblance to the home, which, although shallow, is much deeper and always has an outline closely approximating the shape of the edge of the shell. In some instances on the *Laminaria* the depression is crescentic where it corresponds with only part of the shell. It is concluded that these "homes" are the result of the fretting of the shell against the substratum and not the result of the action of the radula. They are also regarded as more or less fortuitous, depending entirely on local conditions.

Biological Abstracts.

The Naiades of the Green River Drainage in Kentucky.—A. E. ORTMANN (*Ann. Carnegie Mus.*, 1926, 17, 167–88, 1 pl.). Ortmann (1913) pointed out that the forms of the rivers of the Ohio from West Virginia to Licking River had no affinities with the Cumberlandian types. The Cumberland River, also tributary to the Ohio, has many Cumberlandian forms (Wilson and Clark, 1914). Therefore the intervening streams were studied to determine "whether they are intermediate or transitional between the Ohioan and the Cumberlandian type, or whether there

is here somewhere a sharp line separating these two faunas." The Kentucky River studied by Danglade (1922) contains 40 forms. Of these, *Alasmidonta minor* (Lea) was given as a Cumberlandian form. Ortmann now considers *A. minor* a synonym of *A. calceolus* (Lea), a type of the Ohioan fauna. Among the 66 forms of the Green River drainage which are listed and commented upon, there are no Cumberlandian types; also this seems to prove that at some time in the past there was a "disconnection of the waters of Green River and of that system in which the Cumberland fauna originated. The present connection of Green River and Cumberland River, by way of the Ohio, was non-existent." *Biological Abstracts*.

The Structure of the Prostate of the Lymnæidæ.—W. ROSZKOWSKI (Prace Zool. Polskiego Państwowego Muzeum Przyrodniczego, *Ann. Zool. Mus. Polon. Hist. Nat.*, 1926, 5, 1-14, 5 figs.). Considerable differences exist in the Lymnæidæ in the formation of the interior folds of the prostate gland. In *Radix* and *Amphipeplea* one fold exists, whilst in *Galba* several straight unbranched folds may be found; in both cases the folds exist only in the widened portion of the gland. Finally in *Lymnæa* the whole interior surface is covered with folds, from which develop numerous secondary folds. These, with other observations, point to a close relationship between *Radix* and *Amphipeplea*. Generic and specific differences are absent in the arrangement or character of the histological elements. The glandular cells are arranged in groups or "nests," separated from each other by thin layers of connective tissue. The epithelium, lining the lumen of the gland, is ciliated, and rests upon a well-defined basal membrane. *Biological Abstracts*.

Arthropoda.

Insecta.

The Cultivation of Insect Tissues.—J. G. H. FREW (*Brit. J. Exp., Biol.* 1928, 6, 1-11). *In vitro* tissue culture is shown to be a possible mode of experimentation with the tissues of the blow-fly larva. Methods are described whereby the tissues and the body fluids requisite as culture media may be obtained free from bacteria. The imperfections of the technique are noted and the conclusion reached that a successful technique must depend on the rearing of bacteria-free larvæ, for which a method is briefly outlined. It is shown that progress in this part of the work must await further physiological knowledge, particularly in respect to the nature of the body fluids.

G. M. F.

Oriental Carabidæ.—H. E. ANDREWES ("On the Types of Oriental Carabidæ described by V. de Motschulsky," *Proc. Ento. Soc. Lond.*, 1928, 76, 1-24). With the assistance of Mr. Boris Kuzin, of the Zoological Museum of the University of Moscow, the author has been enabled to study a great many of the typical specimens of Motschulsky's collection. Many of Motschulsky's descriptions are so defective that identification of the species has always been difficult, and in many cases impossible. It was the author's object to see examples of as many species as possible, taking the least-known first. This object has in large measure been accomplished, and notes record the results of the examination of examples of about 70 species. All the descriptions which are concerned in this paper appeared either in the *Moscow Bulletin* or in the *Études entomologiques*; in the former case there are six papers, and in the latter six yearly parts. The species have been numbered, and the *Moscow Bulletin* papers have been taken first in chronological order, then the revalent years of the *Études entomologiques* in the same way. The generic names given are those to which the species are now assigned; where

these differ from those employed by Motchulsky, the latter are added in parenthesis. In cases of synonymy an asterisk has been put against the name which is to stand. These indications are often new, but where that is not the case the fact is mentioned. A few species have been redescribed, but only when no adequate description already existed. The 15 brief descriptions of new species included in this paper refer chiefly to the genus *Tachys*.
M. E. M.

British Tachinidæ.—COLBRAN J. WAINWRIGHT "The British *Tachinidæ* (*Diptera*)," *Proc. Ento. Soc. Lond.*, 1928, 76, 139-254, 2 pls., 4 text-figs.). The family *Tachinidæ* is an exceedingly difficult one to study, owing primarily to the fact that the greater part consists of species which are very much alike and possess few tangible characters of specific or even generic value. Unfortunately, moreover, owing doubtless to the fact that the flies are large and conspicuous and everywhere in evidence, they have forced the attention of entomologists, with the result that very many species have been described, and entomological literature is filled with names that one would like to ignore, but may not, attached, as a rule, to wholly inadequate descriptions from which identification is often impossible. The present work is offered merely as a tentative list of the British species of the family, so arranged that it is hoped that it will prove of service to the increasing number of British students whose work, economic and otherwise, brings them into touch with some of these insects, and who desire a ready means of identification; and, further, it is hoped that it may assist the production of a more complete and successful account of the family. In general, the author has followed the nomenclature, arrangement, and limitations of the family as given in Bezzi's and Stein's "Katalog der Paläarktischen Dipteren," vol. III, Budapest, excepting that all reference to the *Hypodermidæ*, *Cestrinæ*, and *Gastrophilinæ* has been omitted.
M. E. M.

Impressionist Colouring in Lepidoptera.—V. B. WIGGLESWORTH ("Impressionist Colouring Among *Lepidoptera*," *Proc. Ento. Soc. Lond.*, 1928, 3, 4). The orange-tip (*Euchla cardamines*) of the *Pieridæ*, a genus having a very limited palette with which to produce their effects—having, on the one hand, only the black melanin pigment, and, on the other, the white, yellow and red uric acid pigments—exhibits the appearance of green colouring on the under surface of the hind wings, an illusion produced by the admixture of black and yellow scales. In the Indian leaf-butterfly, *Kallim inachis*, when viewed at some distance from the eye, the under surface of the wing appears to bear a raised rib exactly like the raised rib of a leaf. When examined more closely, even without a lens, the illusion is seen as three coloured lines—a pale mauve line, a green line, and an orange line. The illusion of relief is given by the blending of the colours, and if the relative luminosity of the constituent tints is altered by viewing them, for example, through coloured glass, the illusion is destroyed, just as it is destroyed by looking too closely at the pattern.
M. E. M.

An Indian Lepidopteron.—W. H. T. TAMS ("A Remarkable Lepidopterous Pupa from India," *Proc. Ento. Soc. Lond.*, 1928, 3, 24-25, 1 text-fig.). Note communicated from Mr. T. Bainbridge-Fletcher: "This reminded me of a somewhat similar case which I came across at Shillong (Khasi Hills, Assam) some years ago. In this case the larva had fastened a silken rope spirally around the stem of a low-growing plant, and had fastened some of its hairs into this rope so as to project outwards at right angles to the stem of the plant, thereafter preparing its cocoon, which is also covered with non-erected hairs, at the upper end of the defended

portion of the stem." An enlarged sketch of a single hair shows that the hairs themselves are provided with recurved barbs well calculated to annoy any foe attempting to climb the stem. The moth had emerged when this specimen was found, and no other has been encountered up to the present. M. E. M.

The Relationship of the Acridine Group.—JAMES A. G. REHN ("On the Relationship of Certain New or Previously Known Genera of the Acridine Group *Chrysochraontes* (Orthoptera, Acrididae)," *Proc. Acad. Nat. Sciences, Philadelphia*, 1928, 80, 189–205, 2 pls.). Through the co-operation of Mr. Bei-Bienko, of Omsk, Siberia, with the author, it has been possible to add to the collections of the Academy representatives of two interesting Palearctic forms of grasshoppers of the sub-family *Acridinae* previously unrepresented in the series. These are *Podismopsis altaica* Zubowsky and *Chrysochraon poppiusi* Miram. Shortly after their receipt in Philadelphia, Mr. B. Uvarov, of the British Museum, asked the author to make a comparison of the genus *Podismopsis* with the North American genus *Chlœaltis* of Harris. In the year 1925 Bei-Bienko had considered Miram's *poppiusi* to be a sub-species of Zubowsky's *altaica*. It was soon evident that any satisfactory opinion of the relationship of the genera *Podismopsis* and *Chlœaltis* could be expressed only after an examination more comprehensive than the mere comparison of these two genera, as the genera *Napaia* McNeill, of the Pacific coast of the United States, and *Chrysochraon* Fischer, previously supposed to be entirely Palearctic, were deeply involved. After considerable study an interesting and, to some extent, revolutionary set of conclusions were forced upon the author, which will require some adjustments of our opinions as to the relationship of certain genera and species, and also the distribution of several of the genera involved, as well as the description of two new generic assemblages. The first conclusion was that *Podismopsis*, as represented by *P. altaica*, is a very distinct entity, occupying a position of isolation as far as the other genera here discussed are concerned, yet clearly of the same general phylum. A comparison of the evident features of *altaica* and *Chrysochraon poppiusi* makes evident at once that the two are not intimately related, and no other species have been seen referable to *Podismopsis*. The general conclusions are summarised and detailed discussions are given, while a few suggestions on the possible movements of several of the genera involved are put forward. It is thought quite probable that definite lines of contact with other groups will become evident from future work. It is certain, however, that the group *Chrysochraontes* as used by Bolivar is, in the inclusion of *Leva* of that author, an arbitrary assemblage, *Leva* lacking real affinity with the genera here discussed.

M. E. M.

Australian Coleoptera.—CHARLES OKE ("Notes on Australian Coleoptera, with Descriptions of New Species, Part I," *Proc. Linn. Soc. of N.S.W.*, 1928, 53, 1–30). The known distribution and descriptions of a large number of species and genera new to science are given in this paper.

M. E. M.

Crane-Flies from New South Wales.—CHARLES P. ALEXANDER ("Crane-Flies (*Tipulidae*, *Diptera*) from Barrington Tops, New South Wales," *Proc. Linn. Soc. of N.S.W.*, 1928, 53, 51–79). The crane-flies were collected by the members of the Sydney University Zoological Expedition to the Barrington Tops, N.S.W., and were sent to the author by Dr. I. M. Mackerras for examination and report. Very few *Tipulidae* have been taken previously on the Barrington Tops, and our knowledge of the flies from the higher altitudes of northern New South Wales is still extremely limited. It is for this reason chiefly that the percentage of undescribed species in the present series is unusually high, including nearly one-half

of the total number taken. The collections considered herein were taken mostly at an elevation of about 5,000 feet during January, 1925. The total number of *Tipulidæ* collected on the Tops is approximately 50, but there are a few species, chiefly in the involved genus *Molophilus*, that are represented only by females and which cannot be finally determined on this material. A complete list of the species is given, the main body of the paper being composed of descriptions of the new species and sub-species.

M. E. M.

Australian Bombyliidæ.—FREDRICK H. S. ROBERTS ("A Revision of the Australian Bombyliidæ (Dipt.), Part I," *Proc. Linn. Soc. of N.S.W.*, 1928, 53, 90–144, 4 text-figs.). While the family Bombyliidæ has been extensively studied in other parts of the world, little has so far been done towards a systematic study of the Australian species. The author has made a study of the material contained in the entire collections of the Queensland Museum, Brisbane, the Australian and Macleay Museums, Sydney, the South Australian Museum, Adelaide, and the Department of Agriculture, Perth. The author describes the general characters of the family and those of the adults, larvæ, and pupæ, and states that little is known concerning the life-histories of the Australian species. The addition in this paper of some of the life-histories of the exotic species may help in elucidating the larval habits of some of the former species at a subsequent time. The genus *Hyperalonia* has been recorded as a parasite of scolid wasps, which are parasitic on *Scarabæidæ* (cane-grubs), and also of the larvæ of an *Asilid*, which also is predaceous on cane-grubs. The classification of the Bombyliidæ is discussed, and a key to nine sub-families is provided. A large number of new species are described, while additional keys are given for the generic and specific determination of the insects referred to.

M. E. M.

Butterflies from South-East Sudan.—G. D. HALE CARPENTER ("Two Collections of Butterflies from the South-East Corner of the Sudan," *Trans. Ento. Soc. Lond.*, 1928, 76, 25–54, pls. I–III, 2 text-figs.). The collections were made by the author on a journey of three weeks' duration along the northern frontier of Uganda in the Chua district in December, 1925. The Didinga country was selected, since, as far as was known, no naturalist had ever visited that remote area, and it was thought that the fauna might yield interesting links between Abyssinia and East Africa. This proved to be the case, and in addition a strong West African element was found, which helps us to understand the presence of West African forms in Abyssinia. The number of species collected in Didinga reaches a total of 117. From the Imatong mountains, about 50 miles to the west, Kent-Lemon sent 56 additional species which were not taken in Didinga. The author lists the groups to which the species belong in these two localities. The *Lycenidæ* and *Hesperiidæ* from the Imatong mountains could not be listed, as there was insufficient time to identify them all. Five species showed sufficient variation from known forms to be described as new geographical races or sub-species. These are *Papilio rex*, sub-sp. nov. *franciscæ*, *P. nobilis*, sub-sp. nov. *didingensis*, *Mylothris ruppelli*, sub-sp. nov. *septentrionalis*, *Amauris lobengula*, sub-sp. nov. *mongallenensis*, *Eagris lucetia*, sub-sp. nov. *obliterata*. Study of the geographical races of many wide-ranging species was of considerable interest, which is increased by the fact that the forms on the Imatong mountains are not always the same as on the Didinga range. There are 13 species either of Western form or transitional towards or from the Western form. Two species, however (100, *Eurytela hiartas*, and 139, *Acraea zetea*), also have Eastern forms. Seasonal forms are discussed, it being stated that certain species well known to exhibit dimorphism were taken

in Didinga. Meteorological records are provided in this connection. In regard to seasonal forms, the species of *Precis* are of chief interest. The *Pierinae* which show dimorphism were not taken in sufficient numbers to enable a definite statement to be made as to whether or not they agree with the seasons, but the few specimens of the three species of *Terias* were all on the "wet" rather than on the "dry" side. A small collection of *Mollusca* was also made in Didinga and has been presented to the British Museum. M. E. M.

Australian Diptera.—J. R. MALLOCH ("Notes on Australian Diptera, no. XIV," *Proc. Linn. Soc. of N.S.W.*, 1928, 53, 295–309). The work was originally undertaken at the request of the late Dr. Eustace W. Ferguson, and was intended as an aid to him in his biological work in Australia. The scope of the project, in the course of time, was broadened to include practically all the *Cyclorrhapha* except the *Syrphidae* and some related families. The author has been compelled to adopt a quite conservative course, and it is seldom that he has ventured to present data upon the families other than those he has been personally able to study, even when such data might be used in the classification of Australian forms, unless he considered it absolutely necessary that such data, usually previously unpublished, should be made available to Australian students of Diptera. Among the families and sub-families discussed are the following: F. *Asilidae*; S.-f. *Laphrinae*, Genera *Atomosia* Macquart, *Nusa* Walker, *Laphria* Meigen, *Andrenosoma* Rondani, *Maira* Schiner; S.-f. *Dasypogoninae*, Genera, *Deromyia* Philippi, *Saropogon* Loew, *Chrysopogon* Roeder, *Neosaropogon* Ricardo; F. *Chloropidae*, S.-f. *Botanobinae*, Genus *Parahippelates* Becker, *P. seticauda* sp. nov., *P. parva* sp. nov., including a key to the other species of the same genus, *P. (Terreregina) dasypyleura* n. sub-gen. et sp.; F. *Lonchaeidae*, including a key to the species of *Lonchaea*, Genus *Lonchaea* and species including *L. hilli* sp. nov.; F. *Sepsidae*, Genera *Lasionemopoda* Buda, *Australosepsis* Malloch, and species *Podanema* nov., and *P. atrata* sp. nov.; F. *Piophilidae*, Genera *Chetopipophila* nov. and *C. hyllipennis* sp. nov. M. E. M.

Insect Migration.—C. B. WILLIAMS ("Collected Records Relating to Insect Migration," *Trans. Ento. Soc. Lond.*, 1928, 76, 79–91). In continuation of the author's policy of putting on record the largest possible number of facts relating to insect migration on which alone can a satisfactory study of the subject be based, he gives a series of new observations which have come to his knowledge since the publication of a previous paper in the *Bull. Soc. roy. Ent., Egypte*, 1926. A few of these observations have been made by the author himself, but the majority have been sent to him by correspondents. In all, 35 records are discussed. M. E. M.

Polymorphism in Horned Beetles.—GILBERT J. ARROW ("Polymorphism in Horned Beetles," *Trans. Ento. Soc. Lond.*, 1928, 76, pt. I, 73–7, 1 pl.). The extreme variability of the horns of beetles, as of the mandibles of male stag-beetles and all such secondary sexual features, is an established fact. These structures, therefore, are not independent features, capable, as Darwin supposed, of being improved, through sexual selection, without regard to any other feature. The selection of the largest males will be the same in effect as the selection of the best horned, and *vice versa*. Moreover, the increase of the horns being much greater than that of the body of the insect, the supposed selection upon non-utilitarian principles must, if long continued, lead to the destruction of the species. In some of the most remarkable forms of horned male the displacement of the centre of gravity must already be a hindrance to progression, and, if development were carried much further, first flight and ultimately all progression would become

impossible. But the variations of form of these structures are no less striking than the variations of size and much less simple, and these have received practically no attention. In many cases only a simple progression in size occurs, and changes of a different character have commonly been taken as a sufficient indication of specific difference; but in many cases, when a considerable number of specimens have been compared, this interpretation has been found incorrect. M. E. M.

Butterflies of Eastbourne.—ROBERT ADKIN ("The Butterflies of Eastbourne," *Trans. Eastbourne Nat. Hist., Photographic and Literary Soc.*, supplement, 1928, 9, 1-58, 15 pls.). This small book contains a wealth of information, acquired by the author over a period of forty years, on the species of butterflies which frequent the district of Eastbourne on an approximate radius of seven miles. Interesting data are provided in regard to the species found to occur in this region, their life-history and their bionomics. The book is a valuable addition to the literature of the English butterflies, and should appeal to serious lepidopterists and collectors alike. M. E. M.

Legs and Leg-Bearing Segments of Arthropoda.—H. E. EWING ("The Legs and Leg-Bearing Segments of Some Primitive Arthropoda Groups, with Notes on Leg-Segmentation in the Arachnida," *Smithsonian Miscellaneous Collections*, 1928, 80, no. II, 1-41, 12 pls.). In attempting to work out the homologies of leg segments in a number of the different groups of arthropods, an effort on the part of the author has been made to find the generalised types for such classes as the *Crustacea*, the *Arachnida*, and the *Insecta*, and, by comparing intergrades with these established types, to interpret the homologies as far as possible for each group. In such a comparison the position of the segment in the series is determined, but the procedure of prime importance is the definite establishment of a known segment in the series which may be used as a point of reference. Different methods have been employed for the establishment of a "landmark" segment or, what amounts to the same, a "landmark" articulation. Börner lays great stress on the bend of the leg at the knee, usually regarding such a bend as taking place at the distal articulation of the femur. Snodgrass uses chiefly the trochanter-femoral articulation as a starting point. The following are a few of the author's general conclusions: The generalised type of an arachnid leg appears to possess one more segment than the maximum number of eight allowed by Hansen for the *Crustacea*, but this point needs further investigation. An arachnid so constituted should have the following segments, named from the base to tip: subcoxa, coxa, coxal-trochanter, femoral-trochanter, femur, patella, tibia, tarsus, and pre-tarsus. The generalised pauropod leg is composed of eight rings, which represent, however, only six or possibly seven true segments, the first three of which probably represent the coxa, first trochanter, and second trochanter. The last four segments of the pauropod leg are the femur, tibia, tarsus, and pre-tarsus. The generalised symphid leg is composed of seven true segments, the first being represented by a condyle-bearing plate. They are: subcoxa, coxa, a greatly enlarged trochanter, a much reduced femur, a tibia, tarsus, and pre-tarsus. The generalised thysanuran leg is completely homologous with the pauropod type, with the exception that it possesses a subcoxa, usually in the form of a plate-like structure. The typical collembolan leg possesses a subcoxal segment and either lacks the tarsus entirely or has it represented by a short rudiment at the base of the claws. Other conclusions are reached by the author in regard to the so-called coxal appendages, the primitive insectan type of tarsus, the insect thorax, the so-called intersegmental region of certain thysanurans, the primitive thoracic tergal plates, the primitive thoracic

sterna, the pleural plates, while the subcoxal theory of the origin of the pleural plates is considered sound, and receives further support in these investigations.

M. E. M.

Australian Rhynchota Homoptera.—A. JACOBI ("Results of Dr. E. Mjöberg's Swedish Scientific Expeditions to Australia, 1910-1913. Rhynchota Homoptera. I. Fulgoridæ und Cercopidæ," *Arkiv för Zoologi*, 1928, 19, 4, no. 28, 1-50, with 31 illustrations in text). The paper describes the genera and species collected during the expedition. Many of both genera and species are new to science.

M. E. M.

Nematocera from Kamtchatka.—F. W. EDWARDS ("Entomologische Ergebnisse der schwedischen Kamtchatka-Expedition, 1920-1922 : 16. Diptera Nematocera, excluding Tipulidæ," *Arkiv för Zoologi*, 1928, 19, 4, no. 31, 1-3). The collection of Nematocera was obtained by M. Malaise, and is small, but of interest, as it includes examples of two North American species (*Mycetophila fastosa* and *Chironomus flavicingula*) in addition to holarctic forms such as *Theobaldia alaskænsis*, and North European forms, such as *Pachyneura fasciata*. The author lists four species of *Mycetophilidæ*, one of *Pachyneuridæ*, four of *Culicidæ*, and eleven of *Chironomidæ*.

M. E. M.

Sumatran Staphylinidæ.—MAX BERNHAUER ("Dr. E. Mjöberg's Zoological Collections from Sumatra : 8. *Staphylinidæ*," *Arkiv för Zoologi*, 1928, 19, 3, no. 19, 1-28). The paper lists and describes a large number of tribes, genera, and species, many of which are new to science.

M. E. M.

Lepidoptera from Kamtchatka.—FRITHIOF NORDSTROM ("Entomologische Ergebnisse der schwedischen Kamtchatka-Expedition, 1920-1922 : 15. *Lepidoptera*, I. *Diurna*," *Arkiv för Zoologi*, 1928, 19, 3, no. 21, 1-16). This paper consists of descriptions of the specimens collected.

M. E. M.

Effect of Light on Wing Formation.—A. FRANKLIN SHULL ("Duration of Light and the Wings of the Aphid *Macrosiphum solanifolii*," *Sonderdruck aus Wilhelm Roux' Archiv. für Entwicklungsmechanik der Organismen*, 1928, 113, 1, 210-39). Wingless aphids of the species *Macrosiphum solanifolii*, when reared in continuous electric light, produced almost exclusively wingless offspring. When reared in continuous darkness, with the exception of a few minutes daily, they produced relatively few winged offspring, the result being only a little less marked than in continuous light. When the wingless parents were subjected to alternating light and darkness, the offspring included a varying percentage of winged individuals, depending upon the length of the period of light. With only two hours of light, alternating daily with 22 hours of darkness, about three-fourths of the offspring were winged. With five hours of light, alternating with 19 hours of darkness, almost all the offspring were winged. Eight hours of light in every 24 also resulted in almost all winged offspring, while with 12-hour periods of light and of darkness there were a very few wingless daughters. There is some indication that the 8-hour period produced this result a little more quickly than did either the 5-hour or the 12-hour period of light. Winged parents, when not in or near the gamic phase of the cycle, responded to alternating light and darkness in the same manner as did wingless parents, though there was a stronger tendency for their offspring phase of the cycle, responded to alternating light and darkness in the same manner to be wingless under any given conditions. To produce winged aphids by means of alternating light and darkness, it was necessary to subject their parents to the

alternating conditions. Young aphids, an hour or two after birth, were incapable of being altered, but were winged or wingless, according to the conditions under which the parents lived. When parents were changed from eight-hour light to 24-hour light, they continued to produce winged offspring for approximately two days after the change, wingless offspring thereafter. It is inferred from these and other results that the effect of the periodicity of light is directly upon the aphids and not indirectly through any change in the photosynthesis of the host plant. From the results of his work the author infers that actual wing determination occurs within the last 16-34 hours before birth. How late in this period it takes place, none of the experiments shows.

M. E. M.

Muscidæ from Sumatra.—J. R. MALLOCH ("Fauna Sumatrensis, Family *Muscidæ* (Dipt.)," *Entomologische Mitteilungen*, 1928, 17, 4, 290-303, 3 figs.). In this paper the author presents a list of species of certain genera of *Muscidæ*, from Sumatra, submitted for identification by Mr. E. Jacobson. The type specimens are disposed of in accordance with the desires of the collector. The author describes the species and gives a key for the determination of the species of the sub-family *Phaoniinæ*, genus *Limnophora*.

M. E. M.

The Phylogeny of *Cylindracheta*.—G. C. CRAMPTON ("Anatomical Evidence that *Cylindracheta* is a *Gryllotalpoid*, not an *Embiid*," *Entomologische Mitteilungen*, 1928, 17, 4, 252-57, 1 pl.). The author discusses the suggestion of Giglio-Tos and others that *Cylindracheta* may present a remarkable case of convergent evolution in which an *Embiid* has taken on the general form and structure of a mole-cricket, and states that the insect morphologist may solve at a glance a problem which has puzzled expert systematists, so putting a feather in the cap of the scorned subject of comparative anatomy. After comparing the various anatomical divisions of the head of *Cylindracheta* with those of other *Gryllotalpoids*, and indicating the conformity in structure, the author states: "The only head structures of any value thus immediately show that *Cylindracheta* is a *Gryllotalpoid*, as soon as one glances at them, if he is at all familiar with comparative anatomy." Evidence to support this statement is also adduced from a study of the legs, thorax, etc.

M. E. M.

The Dixidæ of Bern.—H. BANGERTER ("Dixidæ von Bern (Dipt.)," *Mitteilungen der Schweizerischen Entomologischen Gesellschaft*, 1928, 14, 2, 44-5). The *Dixidæ* of Bern are said to be represented by the following species: *Dixa maculata* Meigen, *Dixa nebulosa* Meigen, *Dixa æstivalis* Meigen, and *Dixa amphibia* D. Geer. The larvæ of all these species assume the characteristic U-form, and the author presents notes on their habits and the times of their appearance in nature.

M. E. M.

The Butterflies of Switzerland.—KARL VORBRODT ("Die Schmetterlinge de Schweiz," *Mitteilungen der Schweizerischen Entomologischen Gesellschaft*, 1928, 14, 2, 46-84). This paper consists entirely of a list of some 572 species of Lepidoptera.

M. E. M.

Larva of *Hemiphysalis mirabilis* Selys.—R. J. TILLYARD ("The Larva of *Hemiphysalis mirabilis* Selys (Odonata)," *Proc. Linn. Soc. of N.S.W.*, 1928, 53, no. 217, pt. 3, 193-206). *Hemiphysalis mirabilis* Selys is a tiny metallic green damselfly of very great morphological and phylogenetic interest. It is entirely confined to Australia, the only known localities for it so far being Port Dennison (Bowen), in Queensland, and Alexandra, Victoria. It is one of the smallest of living dragonflies, its expanse of wing being only $\frac{3}{4}$ in. or a little more. De Selys placed it at

the very end of his group or "legion" *Agrion* of the sub-family *Agrioninæ*, next to the genus *Agriocnemis*; in more modern classification this would put it at the end of the family *Cænagriidæ*. In 1913 the author described the appendages of the male and recorded the peculiar mode of courtship of these tiny insects amongst the reed-masses of the backwaters of the Goulburn River at Alexandra, where the insect was studied during December, 1906. Subsequent work by the author and others demonstrated remarkable characters in these insects, and later the discovery of the ancient forms of Zygopterous dragon-flies in the Lower and Upper Permian indicated a very close relationship between the original ancestral type of the whole order Odonata and this Australian genus, while a detailed comparison of the wing venations made it quite clear that *Hemiphlebia* stood isolated amongst existing forms, and must be regarded as the sole representative of a distinct family, *Hemiphlebiidæ*, standing at the very base of the *Zygoptera*. Progress of researches on the order Odonata, in the course of the last twenty years, has picked out this obscure Australian genus from a mass of unrelated forms and set it up as one of the key genera for the right understanding of Odonate phylogeny. As soon as this had been done, it became at once of the utmost interest that the larvæ should be discovered and studied also, in order that it might be seen what evidence was available from such important larval characters as the wing-tracheation, the labial mask, the mandibles, the gizzard and the caudal gills. After an extensive search the larvæ were found in a backwater of the Goulburn River, Alexandra, Victoria, as small, dark brown, sluggish larvæ, clinging closely to the lower portions of the stems of the weed *Myriophyllum*, while a few were found clinging to the bases of the stems of reeds and submerged grasses. A complete description of this larva is given, a separate section being devoted to the description of the larval wing-tracheation, and the author concludes his paper with a general discussion of larval characters.

M. E. M.

Australian Coleoptera.—H. J. CARTER ("Revision of the Australian Species of the genera *Curis*, *Neocuris* and *Trachys*, together with Notes and Descriptions of New Species of Other Coleoptera," *Proc. Linn. Soc. of N.S.W.*, 1928, 53, pt. 3, no. 217, 270-90). Several new species are described, and keys are given for specific determinations.

M. E. M.

Australian Psychodidæ.—CHARLES P. ALEXANDER ("The Australian Species of the genus *Nemopalpus* (*Psychodidæ*, *Diptera*," *Proc. Linn. Soc. of N.S.W.*, 1928, 53, pt. 3, no. 217, 291-4, 2 text-figs.). The remarkably generalised group of *Diptera* that includes *Nemopalpus* Macquart has been represented hitherto in the Australasian region only by *Nemopalpus zelandiæ* Alexander, found in both islands of New Zealand. The discovery of an undescribed species of the same genus in New South Wales is thus a matter of interest. The fly was included in collections of crane-flies sent to the author by Mr. William Heron, and was taken on the Dorriggo Plateau, where the collector has made discoveries of unusual insects. A description of this new species, *Nemopalpus australiensis* Alexander is made, while the systematic arrangement of *Nemopalpus* and its allies is discussed, and a key given to the sub-families of the *Psychodidæ*.

M. E. M.

Races of Anopheles in Europe.—E. ROUBAUD ("Nouvelles recherches sur l'évolution zoophile des faunes d'anophèles en Europe (*A. maculipennis*), d'après les données de l'armement maxillaire," *Annal. de l'Inst. Pasteur*, 1928, 42, 553-618). As a further contribution to the theory that it is the development by anophelines of a preferential taste for the blood of the domestic animals to the blood of man which accounts for the spontaneous disappearance of malaria

in a region under the influence of agriculture, the author has studied what he considers to be different races of anophelines—races living under wild natural conditions and those inhabiting the regions under agriculture. A study of the maxillæ is said to indicate the wild and the civilised races by the fact that on the maxillæ of the former the development and number of the serrations are less than in the latter. The author is of opinion that the structural difference is to be explained by the adaptation of the maxillæ of the civilised races of Anophelines to the hide of the domesticated animal hosts for which a preference is acquired. It is argued that the "maxillary index" thus affords an indication in connection with anti-malaria considerations as to whether a particular race of Anophelines in any district lives mainly on the blood of domesticated animals or is likely to attack man, since the wild races are more indiscriminate in their tastes. The author advances the hypothesis that the conversion of the wild race of *A. maculipennis* to the domesticated animal host race has its origin in the processes of agriculture, whereby the adventitious breeding-places under natural conditions are replaced by waters of a permanent nature for man's purposes, and an established source of blood becomes available from his stabled animals. Life is thus made easier and more secure for the Anophelines, which slowly adapt themselves to this civilised mode of life, and finally leave man free from their attentions. Wesenburg-Lund, in 1921, pointed out the fact that the variations in the form and development of the maxillæ were probably correlated with the character of the skin of the normal host. Roubaud's hypothesis, which is based on Wesenburg-Lund's suggestion, is well supported by the observations made in this paper, and is in accord with the general observations elsewhere.

M. E. M.

Orthoptera of Montana.—MORGAN HEBARD ("The Orthoptera of Montana," *Proc. Acad. Nat. Sciences, Philadelphia*, 1928, 80, 211–306, 1 map, 2 pls.). The work is based on a study of the State collections which have been assembled at the Montana State Agricultural Experiment Station, largely through the efforts of R. A. Cooley. Although the material was taken by those principally assigned to economic studies, the author is satisfied that exceedingly few species which are not represented will be found to occur in Montana. In the present paper over 7,960 specimens are reported, including 62 genera and 124 species and races, of which one species and two geographic races are described as new. The author, with Mr. James A. G. Rehn, collected at a number of localities in Montana in 1909, and personally secured additional material there in 1904 and 1922. Only the more interesting material from the series then taken, and also that from the Bruner Collection belonging to the author, is recorded at the present time. The present paper is modelled on the "Orthoptera of South Dakota," published by the author in 1925. It has been thought unnecessary to repeat the original and best subsequent reference for the species there treated, but this is done for all those not appearing in that publication. A very condensed summary of the distribution and habitat of the Montana species is given, covering five pages, but no attempt is made to define the full area of distribution beyond the general region in which the species is most prevalent. Also the preferred habitat is indicated, it being understood that some of the species occur sometimes in quite different surroundings. The author points out the serious mistakes which are likely to occur if the remarkable similarity in general appearance of certain widely separated species is not taken into account. The examples chosen are of particular value in pointing out the futility of attempting to give keys to separate, by a few characters, even widely distinct species of some genera without discussion of the individual variations which the majority of species sometimes show.

M. E. M.

Crustacea.

Two New Species of Diaptomus from Nigeria.—S. WRIGHT and W. L. TRESSLER (*Trans. Am. Micr. Soc.*, 1928, 47, 373–7, 1 pl.). Two new species of Diaptomus, *D. yabensis* and *D. agegedensis*, are described from Yaba and Agegede, near Lagos. G. M. F.

Relict Amphipods of the genus Pontoporeia.—F. B. ADAMSTONE (*Trans. Am. Micr. Soc.*, 1928, 47, 366–72, 1 pl.). The amphipods of the deeper water of the Great Lakes belong to two relict species of the genus Pontoporeia. These original descriptions were given by Smith in 1874. Recently, however, *P. hoyi* has been found to be identical with *P. affinis*, which is common in the Baltic and Scandinavian lakes. A fresh description, correcting several inaccuracies, is here given of *P. filicornis* Smith. G. M. F.

Homology of Plates, Ontogeny and Phylogeny of Cirripedia.—H. BROCH ("Plattenhomologien, Ontogenie und Phylogenie der Cirripeden," *Paläontol. Zeitschr.*, 1927, 8, 247–62, 6 text-figs.). Literature on cirripedes might readily lead to the false conclusion that the plates are homologous throughout the group, which is by no means the case. Their homologies can be established only by ontogenetic studies. Lepadomorph cirripedes are known to have five primordial plates, the dorsal carina and paired scuta and terga. The pupal stage of *Balanus balanoides* shows the same five plates, which are thus homologous throughout the Cirripedia thoracica. The other plates of the Balanomorph wall are later accessory developments, not certainly to be homologised with the accessory plates of Scalpellidae. The wall is primitively pentamerous, consisting of a carina, paired lateralia and paired rostrolateralia. The last pair subsequently become conerescent, forming a false "rostrum." This stage is represented by *Tetrachita*, which is primarily tetramerous. In *Balanus* paired carinolaterals are produced by fission of the lateral plates, the "rostrum" still being formed of two conerescent rostrolaterals. In *Chthamalus* the rostrum is regarded as a new plate introduced between the rostrolateralia. The more numerous plates of *Octomeris* and *Catophragmus* are due to splitting of primary plates, these being specialised groups. A criticism follows of Ruedemann's views on the phylogeny of Cirripedia and their origin from Phyllo-pods. The hypothesis of Clarke and Ruedemann that the Lepadomorpha and Balanomorpha were derived from separate ancestral stocks is considered erroneous. The older view that Balanomorph forms were derived from Lepadomorpha is upheld. *Biological Abstracts.*

Distribution of *Daphnia carinata* and *D. lumholtzi*.—W. K. DECKSBACH ("Zur Verbreitung von *Daphnia carinata* King und *Daphnia lumholtzi* Sars., *Zool. Anzeiger*, 1926, 69, 106–10, 1 map). The author reviews the literature, particularly Russian, and shows that *D. carinata* is eurythermal and eurytrophic in small bodies of water, and is limited ecologically rather than geographically. The distribution of *D. lumholtzi* is mapped and shown to be very similar to that of *D. carinata*. *Biological Abstracts.*

Regeneration in *Artemia salina*.—G. FADDA ("Sulla rigenerazione nella *Artemia salina* di Cogliari," *Natura (Milano)*, 1926, 17, 20–3). Specimens from which the first pair of antennæ had been removed survived up to three months. No cases of complete regeneration occurred. Partial regeneration was limited to a trace on the margin of the wound. There was a tendency of the new growth to assume somewhat the form characteristic of the part removed. *Biological Abstracts.*

Animal Life of Ponds on the Flood Plain of the River Oka.—

A. N. BOLDYREVA (*Arb. Biol. Oka-Stat.*, 1926, 4, 125–60, 5 text-figs.). The succession of the Cladocera, Copepoda and Rotatoria in the ponds left on the flood plain of the Oka after the spring floods was studied. Fed by the melting snow, the river overflows its banks late in April or early in May, gradually rising 1.25 m. and uniting all the ponds. The flood recedes in May and many of the ponds dry up during the summer. They belong to three groups: (1) ponds with sandy loam bottom, very little mud and no vegetation; (2) ponds with muddy bottom and abundant vegetation; (3) swamps with loamy, muddy bottom and scanty vegetation, connected either with a pond or a permanent pool. Group 1 is characterised by the poverty of its microfauna during the spring floods, rapid increase with subsidence of the water, especially of Copepoda and *Asterionella*, with *Brachionus pala amphiceros* fairly common; in early summer *Sida crystallina* and *Simocephalus exspinosus* become dominant, with *Polyarthra platyptera* less abundant; later in the summer these are replaced by *Ceriodaphnia*, followed in the fall by *Chydorus*. Group 2 is distinguished by the abundance of *Diaptomus caeruleus* in July, *Ceriodaphnia* appearing a month later, after it disappearance in ponds of group 1. In swamps of group 3 the microfauna is varied rather than abundant; in early summer *Polyphemus pediculus* is dominant, followed later by *Ceriodaphnia*. Common features of all the groups are great ecologic instability, a natural consequence of climatic conditions, complete absence of Harpacticidae and the genus *Moina*. The composition of the fauna during the later summer was substantially the same during the years 1923–1925, and nearly the same in all the ponds. Lists are added of the 60 species of Crustacea and 72 of Rotatoria examined.

Biological Abstracts.

The General Morphology of Harpacticoida.—A. MONARD ("Note sur la morphologie générale des Harpacticoides," *Rev. Suisse Zool.*, 1926, 33, 427–30). The Harpacticoida comprise about 180 genera and 900 species. Their primitive form appears to be cylindrical, slightly swollen in front. It is modified in several ways: (1) by excessive lengthening (*Cylindropsyllidae*); (2) by segmentary constrictions giving a scalariform appearance (*Laophontidae*, *Cletodidae*); (3) by dorso-ventral flattening (cyclopoid (*Idyaea*) when the abdomen is not involved, isopodoid when all segments are involved (*Peltidiidae*, *Porcellidiidae*)); (4) by dorso-ventral thickening, giving bossed forms (*Metis*, *Westwoodia*); (5) lateral compression, accompanied by ability to roll up (*Tegastidae*). The rostrum is very variable. The furca seems originally to have been cylindrical and of the length of the last abdominal segment.

Biological Abstracts.

Ostracoda.—W. KLIE (*Biol. Tiere Deutschlands Lief.*, 1926, 22, 1–16, 43 text figs.). Of the 1,000 species of Ostracoda known, the vast majority live in the sea. The remainder, those inhabiting fresh or brackish water or salt water inland, comprise the entire sub-family Cyprinæ and most of the sub-family Candocyprinæ, of the family Cypridæ, and the small family Darwinulidæ. Not quite 100 species have been found in the fresh waters of Germany. Scarcely any type of waters is free from Ostracoda. They live in subterranean waters, in wells, in running streams, still waters, bog waters, periodic waters, salt waters of the interior, and brackish coast waters. A list of species is given for each habitat. The author discusses their morphology, systematic position, anatomy, mode of reproduction, life-history, distribution; fossil forms, parasites and commensals, and gives a bibliography. The following are figured: *Eucypris nobilis*, *E. ornata*, *E. inflata*, *Cyprideis litoralis*, *Candona rostrata*, *C. parallela*, *C. reducta*, *C. fabaeformis*, *Limnocythere inopinata*, *Herpetocypris reptans*, *Cypris pubera*, *Cypris marginata*, *Noto-*

dromas monacha, *Cyprinotus incongruens*, *Darwinula stvensoni*, and *Palæocypris edwardsi* (Upper Carboniferous, St. Etienne). *Biological Abstracts.*

Brood Cave in Some Malacostraca.—O. JANCKE ("Über die Brutpflege einiger Malakostraken," *Arch. Hydrobiol.*, 1926, 17, 678-98, 12 text-figs.). In almost all the Malacostraca examined, fresh water is conveyed through the movement of the brood plates. Only the amphipods *Gammarus pulex*, *Goplana ambulans* and *Corophium longicorne*, are exceptions; in them there is a renewal of water through the waving of the pleopods. In *Asellus aquaticus*, *Idothea viridis*, *I. balthica tricuspidata*, and *Mysis vulgaris*, are found special contrivances for eggs and embryos. In *Asellus* the leaf-shaped processes form a closing contrivance for the older eggs and younger larvæ. The broad chambers of *Jera marina*, *Tanaïs ørstedii*, and *Anthura gracilis* also are described. *Biological Abstracts.*

Biology of Free-living Copepoda of Halle.—G. HEBERER ("Beiträge zur Biologie der freilebenden Kopepoden der Umgebung von Halle a.s.," *Zeitschr. Naturwiss.*, 1926, 87, 105-86, 1 pl., 16 text-figs.). The general biology, locomotion, and development of the freshwater Copepoda of the region are discussed. The relation between locomotion and habitat is especially noted. An annotated list is given of the six Centropagidæ, 22 Cyclopideæ, and six Harpacticidæ occurring in the vicinity of Halle. The gametogenesis of *Diaptomus castor* is described. Individual variation and the annual cycle of *Diaptomus salinus* are noted. Races and gametogenesis in *Cyclops strenuus* are discussed. The annual cycles of certain Copepoda and Cladocera found in one of the Ruchtendorf ponds are also discussed in detail. Graphs are given to a common scale for the abundance of most of these forms. All have minima in October and November, except *Cyclops bicuspidatus* and *Chydorus sphaericus*, which have secondary maxima. In March and April *Diaptomus castor*, *Cyclops strenuus*, and *C. bicuspidatus* have their maxima. *Daphnia*, *Ceriodaphnia megops*, and *Cyclops gracilis* come to maximum in June and July, followed by *Chydorus sphaericus* in August. It is followed in August and September by *Diaptomus caeruleus* (*D. vulgaris*). *Biological Abstracts.*

The Segmentation of the Trilobite's Head.—K. HENRIKSEN (*Dansk. Geol. Foren.*, 1926, 7, 1-32, 27 text-figs.). The structure of the most generalised recent Arthropods, i.e. the crustaceans, must be the basis for homologising morphological elements of the trilobite's head. Five pairs of head appendages are present in the trilobites, one of antennæ and four of legs of the same shape as those of the body segments. As the antennæ are setiform, many-jointed, and simple to the very base, they must be interpreted as antennules (A_1). The following four pairs are similar; none is shaped like a typical mandible. The last pair is on the posterior part of the head. This occipital segment is different from the anterior part of the head in shape and armature, but agrees in these respects with the body segments. The developmental stages show that it is isolated from the embryonal telson and incorporated in the head at a later stage than all the foremost parts, which are present, though not all separate, in the youngest protaspis stages. The occipital segment must therefore be termed a maxilliped segment and its appendages maxillipeds. In most of the trilobites the upper side of the head shows a frontal lobe and three pairs of lateral lobes or glabella, corresponding to the appendages in front of the maxillipeds. As this number is one less than the number appearing in recent Arthropods (A_1 , A_2 , Mdb Mx_1 , Mx_2) and A_1 is surely recognised, one pair of limbs has disappeared. In the recent *Apus* A_2 may quite disappear and in many genera of trilobites, e.g. *Calavia*, the frontal lobe is indistinctly divided into an anterior and a posterior part, indicating that the A_2 segment

has fused with the A_1 segment and its limbs (A_2) have disappeared; the limbs of trilobites must thus be termed A_1 Mdb Mx_1 Mx_2 Mxp . As to the preantennal part of the head, the ocular segment, the movable cheeks are the pleura of this segment, just as the fixed cheeks are those of the posterior segments combined. As to the manner of ecdysis, the author follows in detail the varying ecdysal sutures in the families, starting with the Mesonacids as the most generalised. In this group a marginal furrow is present, extending all along the border of the head and independent of its segmental limits. A fragile line connecting the border anteriorly with the fore edge of the eye is often seen in the Mesonacids. In most other families this line has become soft-skinned, and, together with the posterior part of the segmental limit between eye segment and the following segments, forms the facial sutures as ecdysal lines. During moulting the two facial sutures are connected anteriorly by a transverse furrow, the last remnant of the reduced marginal suture. The median separated part of the eye segment forms the so-called rostrum. The facial sutures are of importance for animals having well-developed eyes, the latter easily getting rid of the old cuticle at moulting, and have appeared with the increasing size and importance of the eyes. Some blind forms which can be interpreted as relatives to ocular families (*Rhaphiophora*, *Placoparia*, *Pagetia*) have retained the facial sutures, while *Conocoryphe*, *Agnostus*, *Trinucleus*, *Harpes*, all having a flat head just as the Mesonacids, still possess a large marginal suture and no facial sutures, showing a relationship to the Mesonacids along quite another line of descent.

Biological Abstracts.

Annelida.

On the Structure of the Branchiæ of the Gilled Oligochæte *Alma nilotica*.—N. GRESSON (*Ann. and Mag. Nat. Hist.*, 1927, 19, 348–60, 10 text-figs.). Following a brief introductory reference to previous accounts of branchiate oligochæta, the author gives a detailed description of the branchiæ, dealing especially with their external form, relation to body walls, histology and circulation. All layers of the body wall except the longitudinal muscles continue into the gills, and the gill cavities communicate with the coelom. The afferent branchial vessels arise from the parietal branches of the ventral vessel and give rise to vascular loops in the gills, which again unite to form the efferent branchials emptying into the commissural vessel. The very few gilled Oligochæta known are distributed among four families, and differ so much in position and structure that there is no possibility of common origin. Any resemblances are due to convergence.

Biological Abstracts.

Oligochæta from the Region of the Volga and Kama.—W. MICHAELSEN ("Oligochæten aus dem Gebiet der Wolga und der Kama," *Arab. Biol. Wogla-Sta.*, 1926, 9, 1–12, 1 text-fig.). Eighteen species of twelve genera and four families are listed with locality notes, including *Edmondiella simplex* an Enchytraeid. A form considered as probably a variety of *Enchytraeus buchholzi* Vejd. is described, but not named. Critical notes are given on *Pristina aquisetia* Bourne and *Macrochaetima intermedia*.

Biological Abstracts.

Oligochætes of Lake Baikal.—W. MICHAELSEN ("Zur Kenntnis der Oligochæten des Baikal-Sees," *Russ Hydrobiol. Zeitschr.*, 1926, 5, 153–74, 1 pl.). A list of 16 species is given. Tubificidae: *Lycodrilus* of Grube is identified as a synonym of Claperède's *Limnodrilus*; *Limnodrilus dybowskii* (Grube) (= *Lycodrilus dybowskii*) is redescribed in part; *Limnodrilus arenarius*. Lumbriculidae: notes on variation in *Lamprodrilus pygmaeus* Mich.; *L. semenkewitschi* Mich. is redescribed

in part; *Agriodrilus vermivorus* Mich., a highly interesting form regarded as annectent between Oligochaeta and Hirudinea, is redescribed at length and discussed comparatively; ♂ sex organs of *Rhynchelmis elrodi*, *Branchellion torpedinis* and *Drawida* sp. are figured.

Biological Abstracts.

Gastrotricha.

Morphology and Relationship of the Aberrant Gastrotricha.—

A. REMANE ("Morphologie und Verwandtschaftsbeziehungen der aberranten Gastrotrichen," *Zeitschr. Morph. u. Oekol. Tiere*, 1926, 5, 625-754, 82 text-figs.). The systematic position of four peculiar marine Gastrotricha, *Turbanella hyalina* M. Sch., *Hemidasys agaso* Clap., *Philosyrtis monotoides*, and *Zelinkia plana* Giard, has always been uncertain. The original descriptions are in many respects insufficient, and only a single specimen of one of the species, *T. hyalina*, has been recorded since. With abundant material available (Baltic at Kiel) it is now possible to present detailed morphological descriptions of *Macrodasys buddenbrocki* Rem., *Turbanella hyalina*, *T. cornuta* Rem., *Dactylopodella baltica*, *Thaumastoderma heideri*, *Tetranchyroderma hystrix*, *Ptychostomella pectinata*, *Cephalodasys maximus*, *Lepidodasys martini*, *Urodasys mirabilis*. *Zelinkia* is sunk under *Turbanella*, involving *Turbanella plana* (*Zelinkia p.* Giard); *Philosyrtis* Giard is a Turbellarian (Otoplanidae), being sunk under *Otoplana*, involving *Otoplana monotoides* (*Philosyrtis m.* Giard); *Dichætura capricornia* (*Chætura c.* Metsch.), *D. piscator* (*Chætura p.* Murray). The morphological evidence is believed to show conclusively that the aberrant Gastrotricha all belong to a single group, and that their nearest relatives are the normal Gastrotricha. A comparison of the two groups demonstrates the necessity of a redefinition of the class. The Gastrotricha are Aschelminthes of small size (·06-1·5 mm.), elongate, posterior end variable, usually with adhesive tubules; cuticle thin, ciliated on the flattened ventral surface and the head; hypoderm mainly syncytial, with ventral or lateral thickened bands or ridges; mouth anterior, terminal or subterminal; anus dorsal or ventral; alimentary tract straight, divided by a constriction into oesophagus and stomach intestine; oesophagus with triangular lumen, thick-walled, with radial muscles; no gastric glands; stomach intestine unciliated; musculature almost exclusively longitudinal, no circular muscles in body wall; body cavity without epithelium; nervous system with two lateral cerebral ganglia, connected dorsally, and with two longitudinal trunks; ovary without enclosing membrane, paired or unpaired; ♀ genital pore opening through or near the anus; testicles paired or unpaired; ♂ genital pore always ventral; development direct. The two orders included are defined as follows: *Macrodasyoidea*: without oral tube; oesophagus lumen with a side of the triangle ventral, no salivary glands, oesophageal appendages with pore, oesophagus without projection into stomach, more than four rows of cells in wall of stomach, anus ventral; adhesive tubules arranged in an anterior group, lateral rows and a posterior group with more than six tubules; protonephridia wanting; ♂ genital organs fully developed; marine. *Chætonotoidea*: with oral tube; oesophagus lumen with a side of the triangle dorsal, salivary glands present; no oesophageal appendages; oesophagus projects into stomach; four rows of cells in wall of stomach; anus dorsal; adhesive tubules terminal, not more than four, may be wanting; a pair of protonephridia opening separately on the ventral surface; ♂ genitalia unknown. Freshwater or marine. The *Macrodasyoidea* may be divided provisionally into *Thaumastodermidae* (*Hemidasys*, *Ptychostomella*, *Thaumastoderma*, *Tetranchyroderma*), *Turbanellidae* (*Turbanella*), and *Macrodasysidae* (*Macrodasys*, *Urodasys*, *Lepidodasys*, *Cephalodasys*, *Dactylopodella*). From the

morphological evidence it appears highly probable that the Gastrotricha and Nematoda are closely related, more so than Kinorhyncha and Nematoda; the aberrant Gastrotricha apparently narrow the gap between the Kinorhyncha and normal Gastrotricha. The Archiannelida and Gastrotricha agree in so many structural features that it seems impossible to dismiss them all as convergences; the Gastrotricha and Annelida may be considered as related through the Archiannelida. On the other hand, with the addition of the Macrodasyoidea the relationship between Rotatoria and Gastrotricha is shown to be less close than hitherto assumed, and a phylum Trochelminthes is not justified. The Nematoda, Kinorhyncha, Gastrotricha and Rotatoria form a single phylum, for which the old name Aschelminthes should be used. This phylum may be subdivided into: Group 1, Rotatoria; Group 2, Nematodaria, including Gastrotricha, Kinorhyncha and Nematoda. Possibly the Acanthocephala should be considered as Group 3, and the Tardigrada as Group 4. The Scolecidae, including Aschelminthes, Platyhelminthes and Nemertinea, is an artificial group; the Aschelminthes are an independent phylum, which, with Arthropoda and Mollusca, is derived from annelid ancestors.

Biological Abstracts.

A New Classification of the Normal Gastrotricha.—A. REMANE ("Beiträge zur Systematik der Süßwassergastrotrichen," *Zool. Jahrb., Abt. Syst.*, 1927 53, 269-320, 12 text-figs.). The author reviews the existing classifications of the order Chaetonotoidea or Normal Gastrotricha, and is led by his studies of the structural characteristics of many species to look upon one and all as artificial. In this connection he recalls, with many quotations and some approval, the sharp criticisms of Murray (1913). To better express in classification the natural affinities of the species and genera, he has worked out a scheme of arrangement in which this most interesting group is divided into the five families: Proichthyidae nov. fam. (1 genus, Proichthyidium); Chaetonotidae sens. emend. (4 genera, Ichthyidium, Chaetonotus, Aspidiophorus, Lepidoderma); Dichæturidae nov. fam. (1 genus, Dichætura); Gosseidae Daday (1 genus, Gossea); Dasydytidae (4 genera, Dasydytes, Stylochæta, Setopus, Anacanthoderma). To the genera here assigned to the family Chaetonotidae are added two new genera, viz. *Polymerurus*, created to receive the long-toed form *Chaetonotus nodicaudus* Voigt and allied species, and *Heterolepidoderma*, to receive the form known as *Lepidoderma ocellatum* (Metschn.) and some new species closely related thereto. A detailed exposition of the arrangement of the genera and of the reasons for the changes made is supplemented by key groupings of the numerous species of the dominant and difficult genera *Chaetonotus* (including a new sub-genus *Zonochæta*), and *Dasydytes*, which will be most helpful to future students. Some useful names for the distinction of certain structural parts or regions of the Chaetonotoid body are introduced and employed in descriptions, and seven new species are figured and described. A footnote, added during corrections, states that the generic name *Gossea* having unfortunately been found to be preoccupied, the author proposes in its place the new generic name *Neogossea*.

D. B.

The Summer Eggs of Gastrotricha.—A. REMANE ("Zur Frage der Sommerer der Gastrotrichen," *Zool. Anz.*, 1926, 69, 54-6, 1 text-fig.). In a culture of *Chaetonotus persetosus* Zel., among numerous individuals producing single stout-shelled eggs were found two examples in whose body cavities were respectively 9 and 11 small eggs of longish oval form, lacking the thick envelope and already undergoing segmentation. Thereby received striking confirmation the long-discredited observations of Metschnikov, who, as far back as 1865, described and

figured eggs of this type having a length of 19μ as occurring, to the number of 15, in a single example of *Chaetonotus larus*. Metschnikov at the time, suggested that these small eggs bore analogy to the resting eggs of Rotifera. While considering this analogy untenable, Remane points out that it is at least certain that some species of *Chaetonotus* show two absolutely distinct types of eggs, the first a large form frequently met with, of which one only is at any time present in the mother's body and whose development starts only after exclusion, and a second a very rare type of small eggs which are present in the body in greater numbers and whose development commences before exclusion. As to the possible products of the smaller eggs when development is completed, two possibilities are advanced. The first is that they will produce males. Among the Chaetonotoid Gastrotricha, with the exception of a single marine genus lately discovered, neither male sexual organs nor males have yet been observed, but it is in no way impossible that, as in the Rotifera, males do appear at certain seasons and that they have hitherto escaped detection. The second possibility, thought to have little probability, is that these small eggs would produce some sort of a parasite.

D. B.

Rotatoria.

Morphology and Regeneration of *Stephanoceros fimbriatus*.—

CHARLOTTE JURCZYK (Marburg) (I. "Zur Regeneration bei *Stephanoceros*," *Zool. Anz.*, 1926, 67, 333-6, 2 text-figs.; II. "Beiträge zur Morphologie, Biologie und Regeneration von *Stephanoceros fimbriatus* Goldfuss," *Zs. wiss. Zool.*, 1927, 129, 103-52, 1 pl., 20 text-figs.). Some months after the publication by Prof. L. v. Ubisch of the successful results of experiments made to ascertain whether the arms of the corona of the familiar rotifer named above could be regrown if lost through injury (see *J. Roy. Micr. Soc.*, 1926, ser. II, 46, 303), the author in her earlier paper announced briefly the equally successful results of a similar series of experiments having the same aim, but carried on independently at another university. In the later paper she furnishes a very complete account of the general structure and the more intimate anatomical details of the various organs of the body of this animal, both in the short immature or larval stage and in the adult form, together with a more explicit report of the aforesaid experiments by herself. The results of these confirm in all important particulars those given by von Ubisch. Their success is ascribed to the absence from the arms of any cell-nuclei, the arms being prolongations from a basal cingulum built up of thirteen nucleated cells. Experiments were also made upon *Meliceria ringens* and *Cephalosiphon limnias*, but without result.

D. B.

The Rotifer Fauna of Seeburger Lake.—C. KÜNNE ("Zur Rädertier-Fauna des Seeburger Sees," *Zeitschr. Morph. u. Okol. Tiere*, 1926, 6, 207-86, 11 text-figs.). A faunistic and biological study based on fortnightly collections covering several years, during which 65 species were found, including *Monostyla eichsfeldica*. Records are given of annual maxima of each species and of the temporal variations of *Polyarthra platyptera*, *Brachionus angularis*, *B. pala*, *B. urceolaris*, *Amurea aculeata*, *A. cochlearis*, and *Notholca striata*. A tabular comparison of species found in Seeburger Lake, with records for other localities in Germany, is included. Coloured and transparent individuals of *Philodina roseola* are mutually exclusive. *Conochilus unicornis* occurred singly, not in colonies. *Synchaeta oblonga* may occur in numbers during the summer. *Triarthra terminalis* var. *major*, previously known only from Mansfelder Lake, occurs in the Seeburger Lake, as also does *Colurella compressa*, known only from Danzig. *C. compressa*,

C. caudata and *C. lepta* are considered valid species. *Branchionus angularis* var. *bidens* is connected to the typical form by a complete series of intermediates. Transitions were found between the different forms of *Branchionus pala*; the optimum temperature for some of these was about 20° C. A single specimen of *Anuraea cochlearis* occurred without ventral plate; var. *tecta* occurs at all seasons. The occurrence of plankton rotifers depends primarily on temperature of the water and on food supply. Many littoral species occur also in the pelagic zone when phytoplankton becomes abundant.

Biological Abstracts.

Echinodermata.

Cupressocrinus and Rhopalocrinus.—F. A. BATHER ("Notes sur Cupressocrinus et Rhopalocrinus," *Bull. Soc. Belge Geol. Paleontol. et Hydrol.*, 1926, 36, 39–51, 8 figs.). The author describes from the type-locality in Belgium a patina of *Cupressocrinus gibber* Bather, previously known only from arm fragments. It is nearest to *C. inflatus*. Doubt is cast on the reason for *Procupressocrinus* Jaekel, and the existence in Cupressocrinidae of a tegmen above the orals is disputed. It is suggested that the alleged pores in the test of *C. elongatus* are due merely to groups of stroma fibrils. A theca of *Rhopalocrinus gracilis* in the British Museum is described, thus making known the oral surface. The generic diagnosis is revised and the taxonomic position of the genus discussed. The discovery of brachials of *Cupressocrinus* cf. *inflatus* in Calcaire d'Arnao, Asturias, Spain, is announced.

Biological Abstracts.

A New Sea Star of the genus Evasterias.—W. K. FISHER (*Proc. U.S. Nation. Mus.*, 1926, 69, 1–5, 2 pls.). *Evasterias echinosoma*, Albatross Station 3278, 47 fathoms, north of Alaska Peninsula; type in U.S. Nat. Mus. It ranges from Okhotsk Sea and Kamchatka to Bristol Bay, Alaska, 11–48 fathoms; temperature range, 38–41.2° F. *E. troschelii* (Stimpson) includes three forms: (1) forma *troschelii*; synonyms, *Asterias victoriana* Verrill, *Leptasterias macoumi* Ver., *Evasterias troschelii* var. *rudis* Ver. (2) forma *alveolata* Ver. including *Asterias brachiata* Perrier, 1875 (preoccupied), and *Evasterias troschelii* var. *pervispina* Ver. (3) forma *acanthostoma* (Ver.) for Verrill's *Evasterias acanthostoma*.

Biological Abstracts.

A New West Indian Cidarid.—T. MORTENSEN (*Univ. Iowa Studies Nat. Hist.*, 1926, 11, 5–8, 4 pls.). A re-examination of a sea-urchin taken on the "penta-crinus ground" off Havana, Cuba, many years ago, and identified as *Porocidaris sharreri*, shows that it is not that species; it is here described as *Histicidaris nuttingi*.

Biological Abstracts.

Nemathelminthes.

Nematoda.

Sensitising Powers of Proteins of Parasites as Tested by the Isolated Sensitised Uterus Reaction.—A. W. TURNER (*Proc. Roy. Soc. Victoria*, 1926, 38, 24–54, 2 text-figs.). *Ascaris equi*, *A. suilla*, *Toxascaris limbata*, *Onchoecerus gibsoni*, *Fasciola hepatica*, *Gastrophilus hemorrhoidalis*, *G. nasalis*, and *G. intestinalis* were studied. Toluene and glycerol are suitable preservatives, but uterine muscle is affected by low concentration of phenol and chloroform. Guinea-pigs are readily sensitised and react specifically. Group reactions occur with allied parasites, but by a proper sequence of (desensitising) tests, the specific nature of the sensitisation can be demonstrated. With this method the supposed identity of two parasitic forms might be tested or mutilated parasites identified.

Biological Abstracts.

The Species of Mermis : A Group of very remarkable Nemas infesting Insects.—N. A. COBB (*J. Parasitol.*, 1926, 13, 66–72, 1 pl., 1 text-fig.). Literature of *Mermis nigrescens* is reviewed. Meissner's material referred to *M. nigrescens* was a separate species, *M. meissneri*. *M. subnigrescens*, including male, is described and life-history outlined. Species are common in the body cavity of grasshoppers of northern and eastern U.S.A. and Canada. The parasite leaves the host and enters the soil in late summer or early autumn, there moulting and slowly maturing the eggs. The eggs are deposited the following or second following season. Oviposition on plants is stimulated by moisture, light, and temperature. Ovijectio is accelerated by placing labouring ♀ in direct sunlight in warm or cold water; halted by placing her in darkness or deep shadow; ovijectio gradually ceases behind yellowish-green glass and behind green foliage, and is retarded and stopped behind dark ruby glass, but only slightly affected by ordinary blue glass, indicating that the more rapid frequencies among visual rays of sunlight, together with direct heat rays of the sunlight, stimulate ovijectio. These trials accord with April or early May egg-deposition in lat. 41° N. Inhibition due to yellowish-green foliage causes deposition of eggs above green shadows of habitat, hence in good position to be taken in by grazing grasshoppers. The eggs are deposited in batches of 10 to 20, sometimes at rate of about 1,000 a minute, thus nearly emptying uteri during spring morning in lat. 40 to 45° N. Eggs are probably not deposited all at one time or in one season. Females may pass from surface of plants into moist soil in 15 to 30 minutes.

Biological Abstracts.

Platyhelminthes.

Cestoda.

Mammalian Cestodes of South Africa.—J. G. BAER (*Union S. Africa Dept. Agric. Rept. Dir. Vet. Educ. and Res.*, 1926, 11, 63–123, 43 text-figs.). This contribution is based on the study of an extensive collection gathered by Arnold Theiler in Pretoria. The following are described and their systematic affinities discussed: *Lüheellidæ* (fam. nov.); *Luheella pretoriensis*, from *Otocyon megalotis*. Diphylobothriidæ: *Diphylobothrium theileri*, from *Zibethasilurus serval*, *Felis caffra*. Anoplocephalidæ: *Paranoplocephala acanthocirrosa*, from *Otomys irroratus*; *Führmannella transvaalensis*, from *Thryonomys swinderenianus*; *Oochoristica ichneumontis*, from *Herpestes gracilis*; *Inermicapsifer aberratus*, from *Mus. Moggi*. Dilepinidæ: *Dipylidium führmanni*, from *Zibethasilurus serval*, *Felis caffra*. Hymenolepidæ: *Hymenolepis macroscelidarum*, from *Macroscelides brachyrhynchus*. Tæniidæ: *Tænia hyænae*, from *Hyæna brunea*; *T. parva*, from *Genetta ludia*. The descriptions of several cestodes are extended and, in the light of the new information, their taxonomic status critically considered, throwing doubt on the validity of the specific distinctness of a number of parasites. Numerous previously described forms are recorded from new hosts. Scattered throughout the paper are tables listing the distribution of a number of genera in their mammalian hosts and supplying essential data for distinguishing species. In the discussion of a number of genera, the range of variation in certain so-called specific characters is stressed.

Biological Abstracts.

Trematoda.

The Thorny-Headed Worm of Hogs.—H. W. MANTER ("Notes on the Eggs and Larvæ of the Thorny-Headed Worm of Hogs," *Trans. Am. Micr. Soc.*, 1928, 47, 342–7, 1 pl.). *Strategus julianus* Burm, a large grub common in decaying logs, was a very susceptible intermediate host of the thorny-headed worm

of hogs, *Macracanthorhynchus hirudinaceus* (Pallas). The process of hatching is an entirely passive one on the part of the larva, one of the chief factors involved being the marked swelling of the body due to the adsorption of water. G. M. F.

A New Diplostomous Trematode found in the Minnow *Notropis anogenus* Forbes.—H. P. KJERSCHOW AGERSBORG ("Studies on the Effect of Parasitism upon the Tissues. II. With Special Reference to a New Diplostomous Trematode found in the Minnow *Notropis anogenus* Forbes," *Arch. Schiffs-u. Tropen-Hyg.*, 1926, 30, 18–30, 13 text-figs.). Specimens of *N. anogenus* collected at Urbana, Illinois, were infected with *Diplostomum van cleavei*, occurring free in the coelomic cavity or rarely in the liver, not in the intestine; type in author's collection. Three parasites are usually found in each dead minnow; 75 p.c. of the minnows brought into the laboratory died during the first 24 hours. The infected animals swim irregularly, lose their balance, and finally die, apparently from strangulation. The internal organs were partially disintegrated at the time of death. *Biological Abstracts.*

***Digonopyla harmeri* (Graff), a Land Triclad from Celebes with completely separate Reproductive Systems.**—O. FISCHER ("Digonopyla (*Dolichoplana*) *harmeri* (Graff) eine Landtriclade aus Celebes mit vollkommen getrennten Geschlechtsapparaten," *Zool. Anzeiger*, 1926, 66, 257–61, 1 text-fig.). Investigation of specimens at Graz showed that they possessed separate ♂ and ♀ pores. Consequently the genus *Digonopyla* is erected for this form and the new family *Digonopylidae*. *Digonopyla harmeri* n. comb. possesses numerous pharynges and mouth openings, both increasing in number with age. The nervous system resembles that of *Geoplana micholitzii*. The excretory system consists of two main canals which branch greatly and end in flame cells similar to those of many rhabdocels. The ♂ and ♀ genital pores are separate, the former 2 mm. anterior to the latter, both very near the posterior end. The ♀ pore leads into an atrium, which is divided into two chambers, the anterior of which is surrounded by erythrophilous glands and receives the short penis. There are numerous testes, mostly ventrally located. The ♀ atrium extends dorsally and then posteriorly, its posterior end receiving a glandular canal formed by the union of the two oviducts. The ovaries are situated about 1 mm. from the anterior end. *Biological Abstracts.*

The Freshwater Planarians of the Philippines.—P. B. SIVICKIS (*Trans. Am. Micro. Soc.*, 1928, 47, 356–66, 2 pls.). A new species, the habitat of which is permanent shallow freshwater bodies of Luzon, Mindoro and Cebu Islands of the Philippines, is described under the name *P. hymeni* n. sp. G. M. F.

***Bothriocephalus cuspidatus*.**—H. E. ESSEX ("On the Life-History of *Bothriocephalus cuspidatus* Cooper 1917, a Tapeworm of the Wall-Eyed Pike," *Trans. Am. Micro. Soc.*, 1928, 47, 348–55, 1 pl.). After an incubation period of from four to eight days, the egg of *B. cuspidatus* gives rise to a ciliated larva or coracidium, which develops successfully in the coelom of *Cyclops brevispinosus*, *C. bicuspidatus*, *C. prasinus*, *C. leuckarti* and *C. serrulatus*. The procercoid completes its development in the Cyclops from nine to ten days following exposure of the Cyclops to the coracidia of the tapeworm. A second intermediate host is improbable. Plerocercoids, measuring only 0.6 mm., showed the presence of the scolex that is characteristic of the adult. G. M. F.

Two New Species of Planaria from the Balkan Peninsula. S. STANKOVIC ("Über zwei neue Planarienarten der Balkanhalbinsel nebst Bemerkungen

über Verbreitung der *Planaria olivacea* O. Schmidt," *Zool. Anzeiger*, 1926, **66**, 231-40, 9 text-figs.). *Planaria macedonica*, closely related to *P. albissima* and *P. olivacea*, from flowing water, especially springs, in mountainous regions; *P. bosniaca*, from cold springs near Sarajevo, Bosnia. A form resembling *P. olivacea* O. Schmidt, and regarded as a geographical variety of this species, was found in springs in south-western Macedonia and in Dalmatia. These species, with *P. albissima*, *P. paravitta*, and *P. olivacea*, constitute a homogenous group of small, white, spring-inhabiting planarians. Two Asiatic forms, *P. coarctata* Arndt and *P. pellucida* Iij. and Kab., probably belong to the same group. These species are regarded as remnants of an extensive Tertiary fauna spread over all Eurasia.

Biological Abstracts.

Cysticercoïdes from *Gammarus pulex* (L.).—C. JOYEUX ("Sur quelques cysticercoïdes de *Gammarus pulex* (L.)," *Arch. Schiffs-u. Tropen-Hyg.*, 1926, **30**, 433-51). The cysticercoïdes in *G. pulex* reported by Mrazek, Hamann, Daday, and Van Linstow, are reviewed. Studies are made of the detailed structure of the cysticercoïd of *Hymenolepis collaris* Batsch and *Cysticercus integrus* Hamann. The percentage of infestation and seasonal distribution of both species of larvae is noted from collections of crustacea from streams in France at different seasons over several years; 1 to 12 larvae may occur in an individual. Attempting to repeat the work of Hamann, geese and ducks were fed crustacea harbouring the cysticercoïdes of *H. collaris*. The results were negative. However, it is concluded that the diagnostic structures of *H. collaris* as adults found in ducks and the larval forms in the crustaceans represent stages in the same life-cycle. Points of similarity in the known life-cycles of related cestodes are pointed out and comparisons made. The experimental development in the life-cycle of *Echinocotyle mrazeki* Daday is recorded. Three African birds, *Pyromelana franciscana* Ysert, were fed infested *Gammarus*. Two of the birds were free from infestation, while the third after 22 days harboured two incompletely developed cestodes, designated as *E. mrazeki* and known heretofore only in the larval state.

Biological Abstracts.

Is the Present *Polycelis nigra* a Species?—J. KOMÁREK ("Ist die heutige *Polycelis nigra* wirklich nur eine Art?" *Zool. Anzeiger*, 1927, **70**, 70-4, 4 text-figs.). In recent years *P. nigra* has been regarded as including the *P. tenuis* of Tijima. The two species are, however, quite distinct, and *P. nigra* as now recognised and defined is a mixture of two species. The distinguishing characteristics of the two species are given.

Biological Abstracts.

Bifurcation of *Dibothriocephalus latus*.—M. LEON ("Sur la bifurcation de *D. latus*," *Ann. Parasit. hum. et comp.*, 1926, **4**, 236-40, 2 text-figs.). Two cases of bifurcation of the chain are described. In one case one of the chains is constituted of 13 segments. It was observed, in these two examples, that the bifurcation is effected behind the central fenestrations, which are provoked by an excessive oviposition, resulting in rupture of uterine walls.

Biological Abstracts.

Studies on the Trematode family Strigeidae (Holostomidae). No. IX. *Neascus van-cleavei* Agersborg.—R. C. HUGHES (*Trans. Am. Micr. Soc.* 1928, **47**, 320-41, 3 pls.). The account of this parasite given by Agersborg contains several inaccuracies. The species, which is parasitic in various fishes in the Huron River, North America, is closely related to the European *Neascus cuticola* von Nordman.

G. M. F.

Ccelenterata.]

Feeding Mechanism of a Ctenophore.—R. J. MAIN ("Observations of the Feeding Mechanism of a Ctenophore, *Mnemiopsis leidyi*," *Biol. Bull.*, 1928, 45, 69-78, 9 text-figs.). The young capture food with their branched tentacles and deposit it in the mouth. The adults entangle the food with the small tentacles along the tentacular ridge and deposit it in the labial trough, whence it is carried to the mouth. Food enters the stomodæum, and after digestion is cast out of the mouth, or it may enter the food canals and pass out of the anus. G. M. F.

The Species Problem in Coral.—J. E. HOFFMEISTER (*Amer. J. Sci.*, 1926, 12, 151-6). Because of difficulties in the classification of corals, the author suggests that if specimens be found which combine some of the characters of, e.g., *Leptoria gracilis* and some of *L. phrygia*, but appear to lie nearer *gracilis*, that the name *L. phrygia* grade *gracilis* be used. This name should be followed by a careful description, especially of the variable characters. Such a tentative name should be changed if further studies warrant it. *Biological Abstracts.*

The genus Spirocodon: Description of a New Species.—Yo. K. OKADA ("Le genre Spirocodon (hydromeduse). Description d'une nouvelle espèce (contribution à l'étude de la faune marine japonaise)," *Annotations Zool. Japonenses*, 1926, 11, 75-85, 1 pl., 4 text-figs.). The systematic position of *Spirocodon* (Thaumantiatidæ) is given and *S. saltatrix* (Tilæsius) is described. This species is found at only one locality at Misaki, December-April. Its Japanese range is restricted to the Pacific coast between Boshu and Nagasaki, including the Inland Sea. *S. brevitentacularis*, near Misaki, is separated from *S. saltatrix* by its very short and more numerous tentacles and by the fact that its manubrium projects beyond the opening of the velum. The metamorphosis of *S. saltatrix* is described in six stages, leading from the 4-tentacle stage 2.5 mm. high to the adult, tracing the multiplication of the tentacles and the lateral proliferations from the radial canals. *Biological Abstracts.*

Porifera.

The Red Sponges of Monterey Peninsula, California.—M. W. DE LAUBENFELS (*Ann. and Mag. Nat. Hist.*, 1927, 19, 258-66). Bright red sponges are extremely abundant in the intertidal zone of the indicated locality, belonging to four species, including *Acarus erithacus*, *Plocamia karykinos*, and *P. lithophænix*. The fourth, *Ophalitis spongia pennata* Lambe, was originally described as *Desmacella pennata*, the error resulting from the fact that in some habitats this species lacks certain microscleres hitherto considered of great systematic significance. *Acarus erithacus* has definitely triaxon spicules, supposedly characteristic of the order Hexactinellida. This may indicate that some so-called Demospongiæ do not belong in the order Tetraxonida, as generally assumed. *Biological Abstracts.*

Carterius stepanowi (Dyb.) in Eastern Germany, with a Survey of the Freshwater Sponges of Silesia.—K. SCHRÜDER ("Carterius stepanowi (Dyb.) im Osten Deutschlands. Zugleich ein Überblick über die Süßwasserschwammfauna Schlesiens," *Zool. Anzeiger*, 1926, 67, 240-50.) *C. stepanowi* f. *petri* Lauterb. is recorded from this territory for the first time, and is described, including the gemmules, in detail. The union of this sponge with *Spongilla lacustris* was observed but not especially studied. The following algæ are symbiotic with it: *Zoochlorella parasitica* Brandt, *Scenedesmus quadricauda* Breh., *Pediastrum boryanum*

Menegh., and *P. duplex* Meyen. The other freshwater sponges of Silesia are *Spongilla lacustris* L., *S. fragilis* Leidy, *Ephydatia fluviatilis* (L.) and *E. mulleri* (Liebk.).
Biological Abstracts.

Heteromeyenia in Germany.—K. SCHRÖDER ("Über das Vorkommen von *Heteromeyenia repens* Potts (Porifera: Spongillidæ) in Deutschland," *Zool. Anzeiger*, 1927, 70, 75–82, 7 text-figs.). *H. repens*, hitherto known only from North America and an isolated locality in Galicia, was found in ponds in the Elk Valley. A hitherto undescribed envelope was found on the gemmules beneath the layer of amphidiscs. The presence of a primitive membrane surrounding the cell mass of the gemmule, as described by Wierzejski, was confirmed. The amphidiscs are of two sizes, as is characteristic of the genus *Heteromeyenia*. *H. repens* var. *arndti* is described. *Carterius stepanowi* and its variety *petri* are both regarded as varieties of *H. repens*, which then consists of the following varieties: *typica* (Potts), *arndti stepanowi* (Dyb.), *petri* (Lauterb.), *palatina* (Lauterb.), and *bohémica* (Petr.). A table gives the sizes of the spicules and amphidiscs of *H. repens* and its varieties *typica* and *arndti*.
Biological Abstracts.

Protozoa.

A New Trypanosome *Trypanosoma parroti*, pathogenic to *Discoglossus pictus*.—E. BRUMPT ("Un nouveau trypanosome pathogène des vertébrés à sang froid *Trypanosoma parroti* du *Discoglossus pictus*," *Compt. rend. de l'Acad. des Sc.*, 1928, 186, 1160–1). A new parasite which is very pathogenic for *Discoglossus pictus* from Algiers is described.
 G. M. F.

A New Species of *Bolivinita* from the Lower Pliocene of California.—C. C. CHURCH (*J. Paleontol.*, 1928, 1, 265–8, 1 text-fig.). A new species, *Bolivinita angelina*, is described from the Lower Pliocene of the Los Angeles basin.
 G. M. F.

Tertiary Diatoms in California.—G. D. HANNA ("The Lowest Known Tertiary Diatoms in California," *J. Paleontol.*, 1927, 1, 103–27, 3 pls.). The diatoms described were collected from shales which belong either to eocene or oligocene formations. They outcrop on the west side of the San Joaquin Valley from Coalinga to Mount Diablo, California. Fifty-two species are described, of which thirteen are new to science.
 G. M. F.

Recent Foraminifera from San Francisco Bay.—G. D. HANNA and C. C. CHURCH ("A Collection of Recent Foraminifera taken off San Francisco Bay, California," *J. Paleontol.*, 1927, 1, 195–202). A description is given of 37 species taken from bottom sediment in water 75–85 fathoms in depth from San Francisco Bay.
 G. M. F.

Silicoflagellata from the Cretaceous of California.—G. D. HANNA (*J. Paleontol.*, 1927, 1, 259–63, 1 pl.). Five species are described belonging to three new genera—*Corbisenia* Hanna, *Lyramula* Hanna, and *Vallacerta* Hanna. The importance of silicoflagellates as trustworthy horizon-markers is insisted upon.
 G. M. F.

Contractile Vacuole in *Paramecium*.—R. L. KING ("The Contractile Vacuole in *Paramecium trichium*," *Biol. Bull.*, 1928, 45, 59–68, 2 pls.). There are anterior and posterior contractile vacuole apparatuses in *Paramecium trichium*, each of which is permanent and consists of feeding vesicles, contractile vacuole, excretory tube and pore. The contractile vacuoles are vesicle-fed, thus differing

from those of other well-known species in the same genus which are canal-fed. Diastole of the new vacuole is practically complete before the prolonged systole of the old is over, thus giving the appearance of two vacuoles contracting alternately. The excretory tube is long and convoluted, with its flattened cup-like end in contact with the contractile vacuole. It opens as an excretory pore on the surface of the body opposite the mouth. The pore of the anterior and that of the posterior apparatus are located between the same or adjacent rows of cilia. The excretory tube and pore were first demonstrated by the use of Bresslau's relief staining method.
G. M. F.

Eight Well-Defined Species of Paramecium.—D. M. WENRICH (*Trans. Am. Micr. Soc.*, 1928, 47, 275–82, 2 pls.). The following species are described and illustrated, viz., *P. aurelia*, *P. caudatum*, *P. multimicronuleata*, *P. trichium*, *P. buraria*, *P. calkinsi*, *P. polycaryum*, *P. woodruffi*.
G. M. F.

Succession of Protozoa in Cultures under Controlled Conditions.—S. EDDY (*Trans. Am. Micr. Soc.*, 1928, 47, 283–319, 7 pls.). A sequence of protozoan forms occurs in every newly-established body of water. This sequence is most evident in puddles left by rains or by evaporating ponds. Under controlled conditions the following results were obtained: Similar cultures maintained under the same conditions have a similar sequence of dominants in approximately the same abundance. Light has no effect, but temperature, though having no influence on the growth of the individual dominants, does affect the conditions of the habitat necessary for succession. The amount of dissolved oxygen in the infusion is one of the foremost factors governing the sequence of the dominants. Although the *pH* is not an important factor in controlling the succession of the protozoa, it is indicative of other factors which do control the sequence. Soil acts as a buffer and reduces the carbon dioxide, which is toxic to the protozoa of the infusion. Any material subject to fermentation and decomposition will produce the conditions necessary for the various habitats required for the different stages of a succession. While certain genera of protozoa have a common generic response to the conditions of the environment, the occurrence of dominants is probably due to a favourable response to the conditions of the habitat and not to any rate of development. Protozoan succession under natural conditions forms the basis and maintenance of the later succession of the higher forms.
G. M. F.

The Transmission of Theileria dispar, the Agent of Bovine Piroplasmosis of North Africa, by the Tick Hyalomma mauritanicum.—E. SERGENT, A. DONATIEN, L. PARROT, F. LESTOQUARD ("Transmission de la piroplasmose bovine à *Theileria dispar* de l'Afrique du Nord par la teque *Hyalomma mauritanicum*," *Compt. rend. Acad. des Sci.*, 1928, 187, 259–60). North African bovine piroplasmosis is transmitted by the tick *Hyalomma mauritanicum* Sevenet and not by ticks of the genus *Rhipicephalus*, as is East African coast fever. G. M. F.

Amoeba Parasitic in a Marine Diatom.—M. ZUELZER ("Über *Amoeba bidulphia* n. sp. eine in der marinen Diatomee *Biddulphia sinensis* Grev. parasitierende Amöbe," *Arch. Protistenk.*, 1927, 57, 247–84, 5 pls., 2 text-figs.). The author found that, previous to division in amoebæ, a change from gel to sol occurs, apparently a mechanical preparation for division. During the life-cycle of *A. bidulphia* there is a normal physico-chemical change in the protoplasm at regular intervals, probably serving to liberate the infectious developmental stage. The free amoebæ penetrate the diatom, with early ensuing plasmolysis of the host. The amoebæ ingest the host cell contents and increase rapidly in size. Division begins

in 24 hours, and in 2 to 3 days 18 to 32 smaller amœbæ are produced. The amœba protoplasm becomes packed with chromatophores from the diatom, which are digested. Then the amœbæ pass into the surrounding medium, attacking new hosts. If no new hosts are available, they die. With the Biddulphia and its amœba there was also found a flagellate with two flagella and a round brown chromatophore. This also lives on the cell contents of the Biddulphia, but, in the absence of this host, may live on other algæ, diatoms, protozoa, or even small crustaceans. The amœba is usually of the limax type, but at times may thrust out a number of pseudopodia or may even assume a heliozoa-like appearance. The nucleus is vesicular. During division the caryosome passes into solution, to be reformed in the telophase. The basichromatin of the pericaryosomal area forms a spireme which later gives rise to about 20 chromosomes arranged on an equatorial plate. A few cysts were found, but excystment was not observed; no cytological studies were made. Cultures of the amœba on beef bouillon agar prepared either with tap or sea water produced smaller amœbæ than when cultured with the biddulphia in germ-free sea water. Amœbæ in the agar cultures contained a contractile vacuole which the normal animal lacks. When the agar plates were floated in sea water, the contractile vacuoles disappeared in 1 to 2 days. If the plates were floated on tap water, the contractile vacuoles persisted even up to 10 to 15 days.

Biological Abstracts.

The Fibrillar System of Ciliates.—C. G. B. TEN KATE ("Ueber das Fibrillensystem der Ciliaten," *Dissertation Univ. Utrecht.*, 1926, 85 pls., 53 figs.). In this comparative study sublimate-alcohol and Flemming were used for fixation, and Heidenhain's iron hæmatoxylin. Delafield's hæmatoxylin, Giemsa, and Mallory's connective tissue stain for staining. *Opalina ranarum*, *Nyctotherus cordiformis*, *N. ovalis*, *Ichthyophthirius multifiliis*, *Didinium nasutum* and *Balanitidium entozoon* were studied from sections. It is concluded that ciliates unquestionably have fibrillæ, which he designates morphonemes. Myonemes are probably also present, though the characteristic contractions can apparently be ascribed to a fluid plasm to which the name kinoplasma is given. It is certain that many fibrillæ have been incorrectly called myophanes. The presence of neuronemes and of myophanes (Hæckel) is inadequately established. That always all of the fibrillæ of a ciliate are united in a neuromotor apparatus is to be rejected.

Biological Abstracts.

Protozoa of Some Springs of Dobrudscha.—J. LEPSI ("Über die Protozoenfauna einiger Quellen der Dobrudscha," *Arch. Hydrobiol.*, 1926, 17, 751-70). The springs near Cavarina, in south-eastern Roumanian Dobrudscha, are about 80 m. above sea-level and 2 km. from the sea, and empty into a small brook. Vegetation in the springs is limited to plants of the *Amblystegium* association. Water temperature varies throughout the year from 8 to 14° C. Meso- and oligosaprobic conditions were found in the springs. The protozoan fauna is relatively sparse, due chiefly to low O₂ content and lack of food; no seasonal fluctuations were observed. A list of the protozoa of the springs comprises 25 genera and 39 species—6 genera and 13 species of rhizopods; 1 genus and 1 species of flagellates; 18 genera and 25 species of ciliates, including *Egyria peneckeï* and *Holosticha fontinalis*. A comparison of the brook fauna, which is mesosaprobic due to sewage, is made with that of the springs. In the brook fauna 25 species are listed, including *Bizone* (Chiliferidæ, Holotrichida) *parva*. The high percentages of the fauna of the springs found also in the sea indicates origin from the latter; this is supported by geological considerations.

Biological Abstracts.

Skeletal Structures in Infusoria.—L. PESHKOWSKY ("Skelettgebilde bei Infusorien," *Arch. Protistenk.*, 1927, 57, 31-57, 5 text-figs.). Skeletal structures occur as fibres in *Stylonychia*, *Holosticha*, and *Bursaria*. These fibres are found quite generally very close under the pellicle in the species studied. In *Stylonychia* fibres of three types are found. The adoral membranelles are united with fibres of types 1 and 2. The latter unite with the frontal cirri and with fibres running parallel to the adoral zone. The marginal cirri are united with fibres of all three types, of which the first and third have only a strengthening function, while the second move with the cirri. Ventral cirri are connected with fibres which have both a strengthening and probably a contractile function. In *Holosticha* the adoral membranelles and the undulating membranes are united with two systems of fibres, while from the base of the frontal and ventral cirri only one fibre is present. The marginal cirri are united with two fibril systems homologous with the fibres of the second type in *Stylonychia*. In *Bursaria* skeletal fibres occur on the surface and extend to the border of the peristome. Large branched fibres occur on the peristome, and a strong supporting strand is developed around the mouth. To the fibres occurring in the last two ciliates only supporting functions are ascribed. *Biological Abstracts*.

Life-History of *Hartmannella testudinis* n. sp. from Faeces of the Common Tortoise.—MOMČILO IVANIĆ ("Zur Kenntnis der Entwicklungsgeschichte einer aus dem Kot der gewöhnlichen Schildkröte (*Testudo graeca*) gezüchteten neuen *Hartmannella* Art. (*Hartmannella testudinis* sp. nov.)," *Zool. Anzeiger*, 1926, 68, 87-95). A Vahlkampfia and *H. testudinis* were found. A reorganisation process with reduction in number of nuclei is especially stressed. There is a typical vesicular nucleus in the vegetative stages. Between the large karyosome and the nuclear membrane is an outer zone with a network of linin and finely granular nuclear chromatin. Submerged in the karyosome is a linin sphere visible in early division stages. During nuclear division the colouring material of the karyosome largely dissolves. The granules of the outer zone appear to be gradually drawn into the formation of a nuclear plate, collecting around the linin sphere within the karyosome. This linin sphere forms a barrel-shaped spindle. Later the outer zone forms a separate spindle which eventually fuses with the first, giving the typical equatorial plate stage. A visible torsion of the spindle in the later stages is remarkable. Division into two occurs both in adult and in juvenile forms. In schizogony cysts mitosis continues until the cyst is multinucleate. Cytokinesis was not observed in these cysts. "Regulation" cysts have been observed, which become quadri-nucleate through two nuclear divisions. Three of these nuclei degenerate, leaving one functional nucleus. The customary resting cysts are also present. No perceptible changes in the nuclear apparatus are noted in these resting cysts. After a period of rest the animals excyst. All these types of cysts have been found in a single preparation. Encystment is considered to be chiefly an indication of "depression." Disturbances and interruptions of the division processes are not rare. Cytokinesis may fail to follow nuclear division, resulting in multinucleate free animals; the greater the number of nuclei, the larger the animal. Sometimes division fails for both nucleus and cell body, resulting in giant individuals. The author maintains that cell division does not have multiplication as its goal, but is necessary for cell life. Binary fission is a primary phenomenon, other modes of reproduction secondary. The stages in the life-history of *H. testudinis*, excepting binary fission, are regarded as abnormal and the result of pathological conditions.

Biological Abstracts.

Early Stages in the Development of *Leptotheca macrospora*.—H. KALENSCHER ("Studien zur Jugendgeschichte von *Leptotheca macrospora* einer

disporeen Myxosporidie," *Arch. Protistenk.*, 1926, **56**, 357-96, 3 pls., 5 text-figs.). Experimental infections of *Coris giofredi* with spores of *L. macrospora* show that young parasites found in the gall-bladder (soon after the introduction of spores) are rounded bodies with usually two nuclei. The germination of the spore was not observed. The two nuclei fuse, after which two "reduction-chromosomes" are extruded twice from the nucleus. The form undergoes schizogony. During the nuclear division four chromosomes appear. The size of these young forms varies (uninucleate, 6-8 by 5-7 μ ; binucleate, 6-7 by 4-4.5 μ).

Biological Abstracts.

The Genus Ehrenbergina.—J. A. CUSHMAN ("Foraminifera of the genus Ehrenbergina and its Species," *Proc. U.S. Nation. Mus.*, 1927, **70**, 1-8, 2 pls.). *Ehrenbergina* first appears in the Upper Eocene of Mexico, becoming widely distributed in the miocene. The most striking recent species are developed in the Pacific area, where at present the genus is most abundant in species and individuals. In the western Atlantic, especially the tropical and sub-tropical regions, the genus is considerably developed in waters of medium depths. Usually the species occur in rather deep cool waters, not occurring typically in shallow waters. The species are grouped according to the occurrence of the types, the oldest (eocene) species first. Figures of all the species and varieties are given, copied from the type figures. *E. pacifica*, from the Pacific Ocean, and *E. semmesi*, from the eocene of Mexico, are new.

Biological Abstracts.

The Life-Cycle of Histrio complanatus.—J. A. DAWSON (*J. Exp. Zool.*, 1926, **46**, 345-53). Pedigree isolation culture methods were used in this 25-months' study. The length of life of various series of cultures, all descended from a common ancestor, was 756 days; the number of generations attained was 590. The curve for the division rate shows two levels—the first with an average daily division rate of 1.24 lasting for 309 days; the second, a rate of 0.46 lasting for 449 days. No encystment or endomixis occurred in the isolation cultures. Evidence is given to show that the death of the organisms was due to environmental conditions, not to intrinsic factors.

Biological Abstracts.

A New Microsporidian.—P. DEBAISIEUX ("A propos d'une microsporidie nouvelle, *Octosporea simulii*," *Ann. Soc. Sci. Bruxelles*, 1926, **46**, 594-601, 4 text-figs.). In a small number of *Simulium* larvæ (species unrecorded) collected near Louvain, the author observed microscopic cysts, spherical and 150-200 μ in diameter, attached to the intestine at the junction of the latter and Malpighian tubules. They contain various developmental stages and mature spores of *Octosporea simulii*. These cysts are hypertrophied host cells. The spores are bacteria-form and slightly arched, measuring 7.5 by 2-3 μ . In fresh condition a polar capsule is visible at one extremity and a small clear vacuole at the other. In one case the filament was seen extruded, measuring about 40 μ in length. Two nuclei are distinctly observable in fresh spores. Developmental changes await future study.

Biological Abstracts.

Coccidiosis of Domestic Animals in Russia.—W. L. YAKIMOFF ("Les coccidiozes des animaux domestique en Russie," *Bull. Soc. Path. exot.*, 1926, **19**, 262-3). The writer and his students investigated the coccidia of Russian cattle, sheep, pigs, chickens, snakes, and dogs. In 1925, dysentery was observed in cattle near Petrograd. This was usually seen in calves, but often in adults. Post-mortem showed hyperæmia of the large intestine and sometimes ulceration of the

rectum. Oval oocysts were secured, and, from cultures, sporocysts and sporozoites. The species observed are believed to have been as follows—sheep, *Eimeria faurei*; dog, *E. arloigni*; pig, *E. bliecki*; and chickens, *E. avium*.

Biological Abstracts.

Individuality of *Entamoeba dispar*.—E. BRUMPT ("Individualité de l'*Entamoeba dispar*, présentation de pièces," *Bull. Soc. Path. Exot.*, 1926, 19, 399–404). The author splits *Entamoeba dysenteriae* (= *Endamoeba histolytica*) into two species, *E. dysenteriae* Schaudinn 1903 and *E. dispar* Brumpt 1925. The two amoebae are similar in appearance and in size range, but in cats *E. dysenteriae* is fatal, *E. dispar* not. Five cases of *E. dispar*, obtained from three inhabitants of France and two travellers in other countries, were studied in cats. The author believes that the geographical variations of pathogenicity of what has been considered one species can be easily explained by concluding that *E. dysenteriae* is pathogenic to man, *E. dispar* harmless.

Biological Abstracts.

Crescent-Shaped Bodies in Malaria.—A. J. LUKOWA ("Halbmondkörper bei Malaria," *Arch. Schiffs-u. Tropen-Hyg.*, 1926, 30, 183–8, 9 text-figs.) Among 15,000 cases of malaria examined, four showed the rare crescent-shaped bodies occasionally found in blood of malarial patients. The bodies are much larger than normal red corpuscles, the protoplasm is colourless, and the membrane is thickened at one side, giving the characteristic crescent-like appearance. They may or may not contain parasites. A complete series of transitional forms from normal erythrocytes to giant forms indicates that they are degenerating erythrocytes.

Biological Abstracts.

Infection of *Phlebotomus papatasi* with the Parasite of Oriental Sore.—L. PARROT and A. DONATIEN ("Infection naturelle et infection expérimentale de *Phlebotomus papatasi* Scop. par le parasite du bouton d'Orient," *Bull. Soc. Path. exot.*, 1926, 19, 694–6). Of 181 ♀ of *P. papatasi*, only one showed natural infection with the parasite of Oriental sore. However, infection was produced in young ♀ by inducing them to bite white mice previously infected with *Leishmania*. A rapid local cutaneous infection was obtained in the mouse by injecting a culture of *Leishmania* in three sites of the tail. In the first experiments the cages were so constructed that the insects had access to the whole body of the infected mouse; of 43 *papatasi* so fed, six became infected. In the second series only the tail was exposed to the bites of *Phlebotomus*; 11 out of 29 so fed became infected. The *Leishmonas* developed in the digestive tract of the ♀ insect have all the characteristics of *Leishmania tropica*. The infection is limited to the digestive tract of the insect.

Biological Abstracts.

A New Species of *Coccidium* of the Sheep.—A. L. SHEATHER (*J. Comp. Path. and Ther.*, 1926, 39, 79–80, 6 text-figs.). This new coccidium appeared in the faeces of one lamb for nine days only, after which it was detected in two other lambs confined with this one. Oocysts measured 42 + 31–60 + 44 μ . Smaller coccidia (*Eimeria faurei*?) were present in the same sheep. Structural details described show the form to be an *Eimeria*.

Biological Abstracts.

Flagellates of Brackish Waters.—W. CONRAD ("Recherches sur les flagellates de nos eaux saumâtres. II. Chrysomonadines," *Arch. Protistenk.*, 1926, 56, 167–231, 3 pls., 28 text-figs.). This is the second section of a comprehensive survey and arrangement, together with biological observations, of flagellates in brackish waters. Described are: *Chrysapsis ysarensis*, *Chromulina spectabilis*

Scherf., *C. pascheri* Hof., *C. pallida* Pert., *C. ovalis* Kl., *Sphaleromantis ochracea* Pas., *S. subsalsa*, *S. alata*, *Chrysococcus dokidophorus* Pas., *C. rufescens* Kl., *C. radians*, *C. bisetus* (Schil.) nob., *Chrysopyxis bipes* Stein, *C. conica*, *Pedinella hexacostata* Wys. *Mallomonas litomesa* St., *M. mirabilis* Con., *Conradiella pascheri*, *Wyssotzkia biciliata* Lemm., *Derepyxis amphora* St., *D. dispar* (St.) Lemm., *Hymenomonas roseola* St., *H. coccolithophora* (Mass. and Conr.), *Coccochrysis* based on *C. subsalsa*, *Syracosphaera pulchra* Lohm., *Synura uvella* Ehr., *S. adamsii* S. M. Sm., *Ochromonas crenata* Pas., *O. mutabilis* Kl., *O. triangulata* Wys., *Chrysobotrys* based on *C. spondylomorum* *Prymnesium saltans* Mass., *Pascherella* based on *P. yserensis*, *Echinochrysis* based on *E. chodati*, *Nematochrysis sessilis* Pas., and *Thallochrysis pascheri* Con.

Biological Abstracts.

The Morphology and Physiology of *Stentor coerules*.—K. DIERKS ("Untersuchungen über die Morphologie und Physiologie des *Stentor coerules* mit besonderer Berücksichtigung seiner Kontraktilen und konduktilen Elemente," *Arch. Protistenk.*, 1926, 54, 1-91, 4 pl., 28 text-figs.). The existence of "neuroids" ("neurophanen" of Nerescheimer) in *S. coerules* is confirmed and their conductile nature demonstrated. The distribution of the myonemes and neuroids over the cell is described. The existence of a special "food-testing spot" in the mouth region is indicated. The "myoneme canals" of previous writers are said to be fixation artifacts. Peristaltic action of the cytopharynx was observed. Attachment by the posterior end is brought about by suction made possible by the myoneme arrangement of that region. Minute structural details are given for the membranelles, peristome, cytostome, cytopharynx, and pellicle. Physiological effects of Na_2SO_4 and electric induction shocks were studied. *Biological Abstracts.*

BOTANY.

(Under the direction of A. B. RENDLE, D.Sc., F.R.S.)

GENERAL.

Cytology.

Spiral Structure of Chromosomes.—TAKESHIGE MAEDA ("The Spiral Structure of Chromosomes in the Sweet Pea (*Lathyrus odoratus* L.)," *Bot. Mag., Tokyo*, 1928, 42, 191-95). The spiral structure of chromosomes is observed in the pollen mother-cells of *Lathyrus odoratus* in material treated with a suitable fixative. Details of the method of fixation are given. The spiral structure is found in the rod-shaped gemini in diakinesis and metaphase, but cannot readily be demonstrated in gemini of other forms. During anaphase the spiral structure is very clearly displayed by the rod-shaped gemini with subterminal spindle fibre attachment and the ring gemini with submedian fibre attachment. The metaphasic and anaphasic chromosomes do not show the double nature of the spirals as observed in *Tradescantia* species by other authors. As the longitudinal splitting of the chromosomes appears in anaphase, the spiral structure is also clearly manifested and remains in evidence throughout interkinesis. During interkinesis the author finds in his material no anastomoses formed between the chromosomes, which retain the double V, double J, or X shape assumed in anaphase. The spiral structure is maintained throughout the homotypic division up to the formation of the tetrad nuclei. J. L.

Meiosis in *Carex* Hybrids.—OTTO HEILBORN ("Chromosome Studies in Cyperaceæ. I. Reduction Division in *Carex Hornschuchiana* × *C. Oederi*," *Hereditas*, 1928, 11, 182-88). The haploid chromosome numbers of *C. Hornschuchiana* and *C. Oederi* are 28 and 35 respectively. Heterotypic metaphase plates of the pollen mother-cells of the hybrid reveal the presence of very diminutive univalent chromosomes, smaller than any observed in either parent. Their number usually varies between five and eight, though as many as 16 have been seen. Univalents probably occur also amongst the normal-sized chromosomes. The total number of chromosomes in the heterotypic metaphase varies from 34-40. A total of 35 chromosomes would result from the conjugation of the 28 *Hornschuchiana* chromosomes with 28 of the *Oederi* group, the remainder of *Oederi* being present as seven univalents. Autosynopsis between some of these univalents would explain the numbers below 35, while higher numbers would result if less than 28 gemini were formed. The chromosomes are regularly arranged on the equatorial plate and the anaphases also appear regular. From these observations it is concluded that the univalents undergo longitudinal division. Bad fixation renders chromosome counts impossible in the homotypic division, and the chromosome content and viability of the pollen are not determined. J. L.

Carex Chromosome Numbers.—OTTO HEILBORN ("Chromosome Studies in Cyperaceæ. II. Further Chromosome Numbers in Carex," *Hereditas*, 1928, 11, 188–92). The haploid chromosome numbers are given for the following species of *Carex*: *C. capitata* 25, *C. conferta* 26, *C. crus-corvi* 26, *C. tenuiflora* 31, *C. remota* 31, *C. salina kattegatensis* 42, *C. magellanica* 29, *C. atrofusca* 18, *C. silvatica* 29, *C. pulchella* 35, *C. laevirostris* 41, *C. saxatilis* 40 (41?). The localities from which the different material was collected are given. Chromosome size has been studied in *C. atrofusca*. This species has three large and two medium-sized chromosomes distinguishable from the remaining 13. A table is given showing the correlation between systematic characters and chromosome numbers within the genus.

J. L.

Chromosomes of Saccharum.—G. BREMER ("Chromosomal Mutations in Saccharum," *Recueil Trav. Bot. Néerland.*, 1928, 25A, 82–91). A variety of *Saccharum spontaneum* (Glagah Tabongo) from North Celebes has a haploid chromosome number of 40. A self-fertilisation made in 1923 gave a progeny of normal plants and some abnormal giants. The stamens of the giant plants were carpellogic and had a feathered stigma at the top, while the anthers varied from well developed to greatly reduced in size. In these anthers only one to three pollen sacs were developed, while one or more ovules were formed in the remaining anther lobes. Both giant and normal plants showed chromosome numbers greater than that of the parent Glagah Tabongo, their diploid numbers ranging from 96–108. Two self-fertilisations of Glagah Tabongo were made in 1924, and gave a progeny differing from that of the previous year in that very few giant plants were produced, carpellogy was exceptional, the plants mostly showed the haploid number 40 of the parent. The additional chromosomes seem, therefore, connected with the giant structure and carpellogy of the stamens. The cause of these chromosomal aberrations is unknown, but, as all *Saccharum* plants are hybrids, the chromosomal mutation may be the result of the hybrid state.

J. L.

Pelargonium Chromosome Numbers.—FUMI TAKAGI ("On the Chromosome Numbers of Pelargonium," *Science Reports Tôhoku Imp. Univ. Biology*, 1928, 3, 665–71): Chromosome numbers are given for the following species of *Pelargonium*. *P. odoratissimum* 16 ($n = 8$), *P. inquinans* 18 ($n = 9$), *P. hortum* 18 ($n = 9$), *P. peltatum* var. *scutatum* 36 ($n = 18$), *P. zonale* 36 ($n = 18$), *P. domesticum* 45, *P. quercifolium* 45, *P. tomentosum* 45, *P. radula* 81, *P. denticulatum* 90, *P. graveolens* 90 ($n = 45$), *P. glutinosum* 90. All are thus seen to be multiples of nine except *P. odoratissimum*. In the pollen mother-cells of *P. domesticum* about 27 chromosomes are seen, some clearly univalents, and in *P. radula* about 41, some apparently univalent. In root tips of *P. zonale* a few cells are tetraploid with 72 chromosomes. Non-conjunction may occur in the reduction division of the pollen mother-cells of *P. zonale*, resulting in the formation of diads instead of tetrads. This occurs in a greenhouse during mid-winter, and is probably due to lowering of the temperature.

J. L.

Chiasmata in Lilium.—JOHN BELLING ("Nodes and Chiasmata in the Bivalents of Lilium with regard to Segmental Interchange," *Biol. Bulletin*, 1928, 54, 465–70). Bivalents have been studied in *L. longiflorum*, *L. regale*, *L. candidum*, *L. tigrinum*, *L. speciosum* and *L. auratum* from the double thread (diplophase) stage till early heterotypic anaphase. Nodes are observed in the chromosomes at late diplophase. In early diakinesis (diaphase) the twelve bivalents show a total of 39 nodes, one bivalent having five nodes, four having four nodes, four having three nodes and three having two nodes. Forty-three p.c. of these nodes disappear

before late diaphase, at which stage the average number of nodes is 23. At metaphase the average number is about 22. These nodes are undoubtedly chiasmata. The nature of those which disappear before late diaphase is still unknown. Out of 96 bivalents, 31 have one node, 49 have two nodes, and 16 have three nodes. This would result in chromosomes having 31 p.c. with no point of segmental interchange, 48 p.c. with one point, 19 p.c. with two points, and 2 p.c. with three points of segmental interchange. Details are given of the technique used for the cytological preparations and their examination.

J. L.

Somatic Tetraploidy in Crepis.—LILLIAN HOLLINGSHEAD ("Chromosomal Chimeras in Crepis," *Univ. Cal. Pub. Agric. Sciences*, 1928, 2, 343-54). Tetraploidy has been observed in the root tips of two different plants of *Crepis*. One plant, a hybrid derivative of *C. biennis* ($n = 20$) \times *C. selosa* ($n = 4$), had one root which was partly tetraploid. The tetraploid cells with 48 chromosomes were confined to a definite area near the root tip, this area being of irregular shape in cross-section. The average size of the tetraploid cells was greater than that of the diploid. In a plant of *C. Bureniana* ($n = 4$), out of thirty roots examined, two were wholly tetraploid. This condition was undoubtedly the result of doubling of the diploid set of chromosomes, accompanied by increase in average size of cells and nuclei. Multinucleate giant cells occurred in another root of this same *C. Bureniana* plant, with possible evidence of cell and nuclear fusions. It is considered improbable that these abnormal giant cells are concerned with the origin of the tetraploid condition. The tetraploidy in these roots could not be associated with external factors, but may have resulted from either the fusion of nuclei from two cells or the division of the chromosome complex without cytoplasmic division. It is concluded that tetraploidy arising in normal diploid tissue may play a part in the origin of polyploid species and interspecific hybrids.

J. L.

Matthiola Mutants.—M. M. LESLEY and H. B. FROST ("Two Extreme 'Small' Matthiola Plants: a Haploid with One and a Diploid with Two additional Chromosome Fragments," *Amer. Nat.*, 1928, 62, 22-33). A Snowflake trisomic plant crossed with a normal plant of a compact, glabrous, deep-red, pure single race gave an F_1 family in which occurred a hybrid mutant which resembled the small smooth-leaved mutant derivatives from Snowflake. In contrast to the older "small-smooth" mutants, the hybrid "small" type produced seed, part of the progeny resembling the parent mutant. Compared with a normal plant from the same cross, the hybrid mutant had leaves comparatively numerous, small, flat and rigid, smaller size of flowers and fruits and reduced fertility. The progeny of the F_1 "small" mutant were partly normal, partly of the parental type. Cytological examination of the "small" shows them to be trisomic, for in the pollen mother-cells a very small unpaired fragment of a chromosome is present in addition to the seven normal pairs. If this fragment divides at first division, it segregates at the second, and *vice versa*. In the F_2 of 1925 two plants were "extreme smalls," showing intensification of the peculiarities of the ordinary trisomic "small." This indicates a tetrasomic nature. On cytological examination, however, one was found to be a tetrasomic diploid ($7x + 2$) and the other a disomic haploid ($7x + 1$). The similarity of the plants is due to the balance between whole chromosomes and fragments being the same in both. A tetrasomic "extreme small" also occurred in the 1926 culture and resembled the haploid plant. In the haploid 70 p.c. of the pollen mother-cells form dyads as the result of non-reduction, while 30 p.c. undergo partial or complete reduction. The pollen has not been tested

genetically. The somatic cells of the haploid plant show seven large chromosomes and one small fragment. In the two tetrasomic "extreme small" plants reduction usually occurs with the formation of four equal microspores. In both haploid and tetrasomic "extreme smalls" the effect of the additional fragment or fragments is greater than that of the one fragment in the trisomic type. This, and the similarity of both types of "extreme small," provides further support to the genic balance theory of chromosomal effect in development. J. L.

Digitalis Hybrids.—B. H. BUXTON and W. C. F. NEWTON ("Hybrids of *Digitalis ambigua* and *Digitalis purpurea*, their Fertility and Cytology," *Journ. Genetics*, 1928, 19, 269–78). The haploid number of chromosomes in *Digitalis* is 28. The cross *D. ambigua* ♀ *D. purpurea* ♂ was made, but no seed germinated. From the reciprocal, however, fifty hybrid seedlings were raised. The leaves of the hybrid are intermediate in size, shape, length of petiole and serration of the margin. The flower colour is intermediate between the pink of *D. purpurea* and the yellow of *D. ambigua*. The flower is also intermediate in length, but shows greater breadth than either parent. About 200 F₂ seedlings were raised from the only two fertile F₁ plants, partly from controlled, partly from open pollination. In these, segregation is not evident, the leaves and flowers both resembling those of the F₁, though about 50 p.c. of the open pollinated group showed a tendency to revert to the *purpurea* type of leaf. Of the controlled pollinated plants, about 75 p.c. set well-filled capsules, while 25 p.c. were almost or completely sterile. In the open pollinated group no plant set well-filled capsules, though 25–30 p.c. set a little seed in shrivelled fruits. The somatic number of chromosomes is 56 in the F₁ hybrid. The reduction division is very irregular. In diakinesis only 5–12 paired chromosomes are observed. At division a maximum of 12 bivalents divide, the remainder being distributed irregularly over the spindle. These may be approximately equally distributed to the two daughter nuclei or frequently there is complete failure of the reduction division leading to the incorporation of all the chromosomes in a restitution nucleus. In this latter case the second division proceeds normally with the formation of dyads instead of tetrads, resulting in viable microspores with 56 chromosomes. The F₂ plants from controlled pollination have 111–112 chromosomes, while those from natural pollination have 84. In the former the divisions are usually regular, though occasional univalents are seen. It is probable that the triploids are backcrosses with *purpurea* and have, therefore, two sets of *purpurea* and one of *ambigua* chromosomes. These triploids are sterile. The absence of tetraploids from this group of plants indicates marked selective fertilisation. The *Digitalis* hybrid examined is an additional example of a constant intermediate hybrid resulting from chromosome doubling. J. L.

X-Rays on Maize.—L. J. STADLER ("Genetic Effects of X-rays in Maize," *Proc. U.S. Nat. Acad. Sciences*, 1928, 14, 69–75). The frequency of crossing-over in the C-Sh-Wx region in the male germ cells of untreated maize is remarkably constant within the individual. In 1925 the young tassels of three families heterozygous for C-Sh-Wx were treated by X-rays at the time of the maturation divisions. The details of the X-ray exposures are given. A large proportion of pollen was killed by the treatment, the usual percentage of 95 good grains in untreated tassels being reduced to 50 by X-ray exposure. Treated and untreated tassels of the same plant were examined for differences in cross-over frequency in the C-Sh-Wx region, the results showing no appreciable effect of the X-rays. Further experiments were made with a heavier X-ray dosage covering more fully the period of maturation. This treatment caused great reduction in yield and

viability of pollen, the proportion of defective grains often lying between 50 p.c. and 90 p.c., but caused no effect on crossing-over in the C-Sh-Wx region. The percentage of mosaic endosperms showed a marked increase after X-ray treatment. Such endosperms are produced when plants recessive for an endosperm character are pollinated by the corresponding dominant. Genetic evidence has shown that this is due to aberrant chromosome behaviour, but the cytological process is unknown. Ears in which the occurrence of mosaic endosperms was to be studied were X-rayed at the time of fertilisation. The details of treatment are given. The percentage of mosaics in the X-rayed series was more than 20 times as great as that in the untreated series. This effect is possibly due in part to an increase in the frequency of gene mutations as well as that of chromosome aberrations.

J. L.

On the Staining Reactions of Chromosomes.—YOSHINARI KUWADA and TADAZO SUGIMOTO ("On the Staining Reactions of Chromosomes," *Protoplasma*, 1928, 3, 531-35). By various methods of staining performed on both sporogenous and somatic cells of a considerable number of plants, it is seen that chromosomes are electro-negative (Keller) when confined within the nuclear membrane, but electro-positive when directly exposed to the cytoplasm. The "Prussian Blue Method" of Keller gives the opposite result, the metaphasic chromosomes appearing electro-negative.

J. L.

Raphide Cells in Hyacinthus.—WALTER ROBYNS ("L'origine et les constituants protoplasmiques des cellules à raphides du *Hyacinthus orientalis*," *La Cellule*, 1927, 38, 177-91). The periblem cells of the root of *Hyacinthus orientalis* contain bundles of raphides. In these cells a single central vacuole develops in the cytoplasm in contact with the nucleus. This central vacuole enlarges till the cytoplasm finally forms a peripheral lining in which lies the elongated nucleus. The raphides appear in this vacuole and not in the cytoplasm. They are never immediately surrounded by cytoplasm, but in cells sufficiently differentiated a layer of mucilage is seen lying between them and the peripheral cytoplasm. One or more rarely two patches of clearly outlined dense cytoplasm are present in the cells of the periblem which later become differentiated to contain raphides. After raphide formation the cells still contain these dense cytoplasmic patches. After treatment with mitochondrial fixatives, these structures appear as dense homogenous bodies, while when treated with acetic acid fixatives they have a lamellate and alveolar appearance. On account of these differences in appearance according to fixation, they are compared with the "ergastoplasmic" formations in cells of the pancreas, and the name "ergastoplasm" is applied to them. This substance is considered to be actively concerned in raphide formation, though the exact rôle it takes in the process is not known.

J. L.

Intracellular Bodies of Mosaic Disease.—FRANCIS O. HOLMES ("Cytological Study of the Intracellular Body Characteristic of *Hippeastrum Mosaic*," *Bot. Gaz.*, 1928, 86, 50-8). *Hippeastrum equestre* was chosen for investigation because the mosaic intracellular bodies of this plant are large and numerous. Different methods of fixation and staining were used, but in no case was true nuclear material found in the included bodies. Two types of structure were observed which might possibly be of nuclear nature: (1) Granules which retain most stains intensely, but do not give the characteristic nuclear reaction with Giemsa's stain, and which resemble other granules free of the intracellular bodies; (2) spheres containing one or rarely two deep-staining peripheral balls. Such spheres are also found in host cell cytoplasm of diseased plants, but not in healthy plants. The

nature of these structures is not known. The intracellular bodies contained moderate numbers of well-distributed chondriosomes. Their presence favours the view that the bodies of this disease consist of living cytoplasm. Three possibilities are suggested as to the nature of the intracellular inclusions: (1) The body represents a stage in a parasitic organism, or (2) a mass of plant cell cytoplasm containing virus, or (3) a mass of plant cell cytoplasm not immediately in contact with virus, but stimulated by the diseased condition. J. L.

The Chondriome of Normal and Parasitised Ericaceæ.—D. PELLUET ("Observations on the Cytoplasm of Normal and Pathological Plant Cells: the Effect of Parasitism on the Chondriome of certain Members of the Ericaceæ, with a brief Description of their Ecology," *Ann. Bot.*, 1928, 42, 637-64). Pea seedlings were grown in the following solutions—tap water, Pfeffer's solution complete, Pfeffer's solution minus calcium, minus potassium, minus phosphorus. Root-tips first leaves and parts of the stems were fixed in fluids suitable for the demonstration of cytoplasmic inclusions and examined for differences in normal and abnormal material. Negative results were obtained in all cases, even in the phosphorus-free medium, which element the mitochondria themselves contain. This may be explained by the presumption that at such a young stage in the life-history of the plant there is still available a supply of all necessary substances. Normal and fungus-infected leaves of *Vaccinium macrocarpum* and *Gaylussacia dumosa* display cytoplasmic differences. The fungus *Exobasidium Oryzococi* stimulates the host to increased growth of leaf and stem accompanied by pink colouration of the affected tissues. An ecological description is given of the district from which both normal and infected material was collected, and the anatomy of the leaves is briefly recorded. The epidermal cells of normal leaves of both plants contain chlorophyll granules and typical mitochondria. The chlorophyll of the palisade layer of *Gaylussacia* is distributed as small granules in the cytoplasm; definite chloroplastids are present in the mesophyll, and in both these tissues of the leaves of *Vaccinium*. The palisade and mesophyll cells of both plants contain typical mitochondria and large plastids which, by their staining reaction, are of phospholipoidal character. These are not observed in the living material. These plastids are of two types: (1) lens-shaped, deeply-staining with fuchsin, surrounded by a distinct rim and containing highly refractive granules; (2) spherical, faintly-staining, containing granules which stain more deeply than the substratum. These included granules resemble mitochondria and are frequently situated at the periphery of the plastid, giving the impression of being extruded into the cytoplasm. Homogeneous plastids are also recorded. These plastids are probably actively concerned in cell metabolism, the different types possibly representing different stages of synthesis. A description is given of the anatomical effects produced by fungal infection, the chief being the disappearance of differentiated palisade and mesophyll layers accompanied by loss of air spaces and stomata. Typical mitochondria are present in the cytoplasm of the fungus. In the infected leaves the chloroplasts and lipoidal plastids are completely disorganised, with occasional total disappearance of all lipoidal material from the host-cell. Possibly a lipase is excreted by the fungus causing the splitting up of the lipoid granules into their fatty acid constituents and thus rendering them available for absorption by the fungal hyphæ. J. L.

Pigment of Berry of Elder.—T. J. NOLAN and M. T. CASEY ("The Nature of the Pigment of the Berry of the Elder, *Sambucus nigra* L.," *Proc. Roy. Irish Acad.*, 1928, 38, Sect. B, 93-9, 1 pl.). An investigation of the chemical nature and reactions of the pigment of the elderberry. The pigment predominates

in the skin, and differs from that of the various species of vine so far examined. It has been isolated as a chloride in the form of a reddish-brown powder with a strong metallic reflex. This chloride appears to be pure, but cannot be crystallised; it assumes the form of spherical particles, which, under certain conditions, transmit light and at other times show a dark cross on a red field. The chloride can be transformed into the picrate, in brick-red crystalline plates. Its chemical behaviour indicates an anthocyan, and its reactions towards acid and alcohol show that it is a monoglucoside of the rhamno-glucoside type. In many respects it closely resembles delphinidin chloride. The results obtained confirm and supplement those of previous workers, and the writers suspect that the berry contains a glucoside of delphinidin together with a cyanidin glucoside. S. G.

Anatomy and Histology.

The Pit-closing Membrane in the Lower Gymnosperms.—J. G. WRIGHT ("The Pit-closing Membrane in the Wood of the Lower Gymnosperms," *Trans. Roy. Soc. Canada*, 1928, 22, 63-94, 2 pls., 44 figs.). The author briefly summarises the earlier work on the bordered pits of Gymnosperms. The Cycads show stages from the primitive pteridophyte scalariform type of tracheid, as found in *Stangeria*, to elements with a multiseriate type of pitting, as illustrated in *Cycas*. There is a pit-closing membrane in both the side and end walls of the tracheids of the metaxylem in all the forms studied. It is, without exception, delicate and uniform in thickness, with no evidence of a torus. The pitting of *Ginkgo* attains to the round broad-bordered type with oval or round pore. A uniformly unthickened pit membrane is found, but in addition to this several types of torus occur. The typical pitting in the stem of the Araucarians studied is uniseriate and alternately biseriate. The pits are round or oval with broad borders and oval pores. The pit-closing membrane is extremely variable throughout the group. It may be uniformly thick or thin, or show a more or less definitely thickened central torus. All these conditions are to be found within the radius of a single section through a given region. The structure of the pit in the lower Gymnosperms, and particularly the type of pore, appears to be closely connected with the presence or absence of a torus. The torus is found where the pitting is of the round or oval broad-bordered type, and when the pores depart from the elongated slit-like form and become broadly oval or round. *Ginkgo* and the Araucarians, however, provide evidence that the presence of a round pore does not necessarily entail the development of a torus. B. J. R.

Latex Tubes in the Hemp Plant.—A. ZANDER ("Über Verlauf und Entstehung der Milchröhren des Hanfes, *Cannabis sativa*," *Flora*, 1928, N.S. 25, 191-218, 7 figs.). The latex tubes of hemp belong to the unarticulated unbranched type. They occur in those parts of the plant in which phloem is present, but are absent from the roots, the cotyledons and the greater part of the hypocotyl. The contents consist of an almost insoluble yellow-brown granular substance. The tubes are found at the growing point of the shoot, where they first develop when the leaves are formed. They keep pace with the growth of the plant, and by extension and perhaps apical growth attain to a great length. They are therefore cells, not cell-fusions. Certain peculiarities of the latex tubes of *Cannabis* and *Humulus* distinguish them from other Moraceae. These two genera, comprising the Cannaboides of Engler, are therefore entitled to a special position within the Moraceae. B. J. R.

Ontogeny of the Bordered Pit.—V. ALEXANDROV and K. ABESSADZE ("Zur Entwicklung der Hoftüpfel der Kiefertracheiden," *Journ. Soc. Bot. Russie*, 1927, 12, 183-96, 4 figs, Russian with German summary). Seedlings of *Pinus eldarica*, *P. Strobus* and *P. hamata* were studied. The course of development is especially clear in *P. eldarica*. In the pines, as in the lower Gymnosperms, there is a direct development of the bordered pit from the spiral thickenings of the primary elements. In *P. eldarica* two courses of development can be distinguished. The uniseriate pits, characteristic of the Coniferæ, arise from direct fusion of bands of the spiral thickening. In the formation of pits in more than one row cross bands appear joining the spirals. The process resembles the development of the bordered pit in the lower Gymnosperms and in the Angiosperms. In the pine, a typical conifer, the mode of formation of the bordered pits in several rows is interpreted as an atavism. The torus in these pits is particularly weak. At the time of the beginning of bordered pit formation pine tracheids have not less than two nuclei. So long as the nuclei exist, the spiral thickenings possess a certain plasticity in spite of their being already lignified. B. J. R.

Anatomy and Maturation of the Culm of Wheat.—A. D. ATANASSOFF ("L'Anatomie et la maturation des chaumes d'un pied de blé colosse de Razgrad, *Triticum turgidum* L.," *Ann. Sci. Nat. Bot.*, 1928, 10, 1-99, 14 pls.). The anatomy of the young plant and the state of maturity of the internodes are described. Development and maturation begin in the first (highest) internode and spread downwards. After fertilisation food materials are drawn out of the internodes to supply the developing grain. The alteration of the chlorenchyma is an indication of this. The result is that the upper part of the stem reaches maturity before the lower portion. Anatomical maturation of the culm is expressed in the external morphology and confirmed by chemical analysis. B. J. R.

Woods of the Dutch East Indies.—L. G. DEN BERGER ("Beitrag zur Kenntnis der Anatomie des sekundären Holzes der niederländisch indischen Baumarten, I," *Bull. Jard. Bot. Buitenzorg*, 1928, 9, 223-48, 4 pls.). The author claims that the surface examination of woods with a lens gives results which, for purposes of identification, nearly approach those of microscopic examination. This is the first article of a series describing the woods of the Dutch East Indies. The families to be described first are those not hitherto dealt with by Moll and Janssonius. In this article 32 species of 14 genera of the Flacourtiaceæ are described. Each genus is illustrated with a photomicrograph. There is also a key to the identification of the genera. B. J. R.

Structure of the Graft Union.—E. L. PROEBSTING ("Further Observations on Structural Defects of the Graft Union," *Bot. Gaz.*, 1928, 86, 82-92, 6 figs.). A preliminary survey of the structure of the graft union, designed to give an indication of the types of union to be expected, and some idea of whether or not correlation between field behaviour and structure could be observed. The work was carried out at the California Agricultural Experiment Station, largely on one-year-old budded nursery stock of *Prunus* and *Pyrus* species. A high degree of variability is to be found between individual specimens of a given combination. The normal union may be considered to approach the type shown by Prune (*Prunus domestica*) on Myrobalan (*Prunus cerasifera*). In transverse sections of budded material the wood of the stock next the cambium is ordinarily summer wood. When the bud begins growing, spring wood is first laid down, the effect being essentially similar to that produced by the adjacent summer and spring wood of two annual rings. The rays are continuous across the line of union, and the pits

in adjacent cells meet as though the cells were derived from a single source. The cambium cells of the scion form ray cells if they are in contact with ray cells, and xylem elements if they are in contact with xylem elements. One of the commonest types of structural defect is that involving the deposition of wood parenchyma by the cambium at the line of union, interrupting the vascular connection to a considerable extent. In some cases there may be only isolated masses of parenchyma with the vessels making fairly good connections round them. In others the ends of the vessels may be almost entirely separated by these cells. Distortion of the vascular tissue occurs in the neighbourhood of the union in cases where the stock grows much more rapidly or more slowly than the scion. Serious distortion of the xylem is sometimes associated with masses of parenchyma and at times with the degeneration of certain areas to amorphous gummy masses. In another type of structural defect all of the xylem between the rays is degenerated into a gummy mass.

B. J. R.

A Method of Staining Phloem Tissues.—E. S. HARRAR ("A Stain Combination for Phloem Tissues of Woody Plants," *Bot. Gaz.*, 1928, 86, 111-12, 1 fig.). A Bismarck brown Heidenhain's iron-hæmatoxylin combination has been found to give results more satisfactory than those obtained by the usual anilin safranin-hæmatoxylin schedule. The method is as follows: 1. Place the sections in a 2 p.c. aqueous solution of ferric ammonium sulphate for twenty minutes (if the material has been killed and fixed, this time may be reduced by one-half). 2. Drain off the mordant and wash in changes of distilled water. 3. Flood the sections with distilled water and add two or three drops of Heidenhain's iron-hæmatoxylin. Watch the progress of the stain under the microscope and stop at the desired point by a change of water. 4. Drain off the water and immerse the sections in a 1 p.c. aqueous solution of Bismarck brown for three or four hours. 5. Drain off excess stain and dehydrate the sections with changes of alcohol in the usual way.

B. J. R.

Vascular Anatomy of Ranalian Flowers.—G. H. SMITH ("Vascular Anatomy of Ranalian Flowers, II," *Bot. Gaz.*, 1928, 85, 152-77, 26 figs.). A study of unusual flowers of *Ranunculus*, *Caltha* and *Delphinium*, and also of the families Menispermaceæ, Calycanthaceæ, and Annonaceæ. It was found that flowers of *Ranunculus* having more than five petals differ from those with five petals in having a spirally arranged corolla; all the stamens have been transformed into petals and the carpellary region has been suppressed. In the double garden forms of *Caltha palustris* the stamens have been expanded into petal-like structures, and the vascular supply of the terminal carpellary region has disappeared together with this region itself; the vascular system of the transformed stamens has also disappeared. The vascular anatomy of *Delphinium* shows similar modifications. In *Menispermum* the vascular anatomy is of the same fundamental structure as that of the Ranunculaceæ, with two modifications, viz., the flowers may be differentiated into purely staminate ones or perfect flowers with non-functional stamens. *Calycanthus* has the suggestion of a cortical vascular system; the hollow flower-cup is due to the checking of the growth of the apical portion of the primordia of the receptacle, while the bulging up of the surrounding meristematic tissue has resulted in an inferior ovary. In *Asimina* the shape of the flower-cup differs from that of *Calycanthus*, and the two cortical vascular systems have no common characteristics which may indicate that the perianths of the two genera are not homologous structures. The floral organisation of the groups studied supports the view that the more primitive flowers have multiovulate carpels; the lowest stamens may be

normally petaloid, and they may all be transformed into petals; the sepals are also liable to modification. All floral parts are spirally inserted and of indefinite number. The vascular skeleton of the Menispermaceæ, Calycanthaceæ and Annonaceæ appears to be derived from the Ranunculaceæ. The Menispermaceæ have probably arisen from a member of the Ranunculaceæ having a tendency towards cyclic arrangement and a general reduction of parts to a definite numerical plan. The Calycanthaceæ have evolved as a side branch from the Ranunculaceæ by reduction of the apical floral primordium and bulging up of the surrounding parts. The Annonaceæ have a vascular system based on that of the Ranunculaceæ with the addition of a partially developed cortical system. These studies point to the Ranunculaceæ as the centre of evolution of the other groups. S. G.

Pollen-Grains of Ambrosiaceæ.—R. P. WODEHOUSE ("Pollen-Grains in the Identification and Classification of Plants. I. The Ambrosiaceæ," *Bull. Torr. Bot. Club*, 1928, 55, 181–98, 1 pl., 1 fig.). The first of a series of studies aiming at showing to what extent the relationship of different plants and groups of plants are revealed in the forms of pollen-grains. The pollen-grains of the Ambrosiaceæ are tricolpate, but differ from other Carduaceæ in a reduction of the spines. The pollen of closely allied genera or species exhibit characteristic similarities. The various forms show three evolutionary tendencies, i.e. (1) Reduction of the spines (2) shortening of the furrows, (3) increase in size. The pollen-grains of *Euxanthium* and *Acanthoxanthium* exhibit differences as striking as those seen in the anatomy of the two sections of the genus *Xanthium*. The suggestion that *Franseria* is a transition genus between *Ambrosia* and *Euxanthium* is supported by the characters of the pollen. The relationship of the Ambrosiaceæ to *Parthenium* and *Parthenice* is confirmed by the long narrow furrows, sharp conical spines, somewhat granular texture, and small size of the grains of these genera and the primitive forms of the Ambrosiaceæ. No similarity is seen to other groups of the Heliantheæ, but there appears to be a remote relationship to the Anthemideæ. S. G.

CRYPTOGAMS.

Pteridophyta.

Lepidodendron Stem.—COLIN BARNARD ("A Note on the Structure of a Lepidodendron Stem from the Lower Carboniferous of New South Wales," *Ann. Bot.*, 1928, 42, 665–75, 1 pl., 5 figs.). An account of the structure of a fossil fragment of *Lepidodendron* stem found near Wallaroba, in New South Wales, describing its primary xylem, the secondary xylem, and the leaf traces, and discussing its affinities. It is the only lepidodendroid petrification yet discovered in Australia. It is unsafe to assign it definitely, on anatomical grounds alone, to any particular genus. A. G.

Embryo of Equisetum.—D. H. CAMPBELL ("The Embryo of *Equisetum debile* Roxb.," *Ann. Bot.*, 1928, 42, 717–28, 1 pl., 10 figs.). An account of the structure of the embryo of *Equisetum debile*, from material gathered near Lahore, in India. The gametophyte is very large and develops many embryos. The early divisions of the embryo are much less uniform than in *E. arvense*. The first or basal wall varies from horizontal to vertical; the shoot-apex and probably the root are of epibasal origin, while the hypobasal portion forms the very large foot. The root and other organs are differentiated later than in *E. arvense*. Three leaves, rarely four or two, are found in each whorl of the primary shoot. The foot is very conspicuous, and the boundary between root and hypocotyl is vague. The basal bud, which gives rise to the second shoot, is endogenous, and arises from the root.

Both gametophyte and sporophyte show that the species of the subgenus *Hippochaete* are more primitive than those of *Equisetum*. In the development of the embryo and young sporophyte there is evidence of a real relationship between the Equisetales and the Eusporangiate ferns.

A. G.

Equisetum debile.—MOHAN LAL SETHI ("Contributions to the Life-history of *Equisetum debile* Roxb.," *Ann. Bot.*, 1928, 42, 729-38, 1 pl., 1 fig.). An account of the development of the archegonium and of the antheridium of *Equisetum debile*, which occurs abundantly in the vicinity of Lahore; some details of fertilisation also are given. The development of the embryo is described, together with certain occasional departures from the normal course.

A. G.

Equisetum.—JOHN H. SCHAFFNER ("Fluctuation in *Equisetum*," *Amer. Fern Journ.*, 1928, 18, 69-79). *Equisetum* is a specialised primitive plant which fluctuates in the variation of its parts more than any other vascular plant. Variability in the constituent parts is discussed as follows: Fluctuation in the sheath segments and internodal ridges; discoloration of sheaths; abscission of sheath-teeth; fluctuation in length of internodes; fluctuation in branch whorls; general habit; fluctuation in the silex; amplified sheath; intergradation between vegetative and floral shoots; the calyx and sporophylls; the peduncle; terminal point of cone; loss of chlorophyll in reproductive shoot. Though many "varieties" of *Equisetum* have been described, few of them have any taxonomic value; they represent mere fluctuations, two or more of which may be present in one individual plant.

A. G.

Fossil Tree-Ferns.—YUDZURU OGURA ("On the Structure and Affinities of some Fossil Tree-Ferns from Japan," *Journ. Faculty of Science Imper. Univ., Tokyo, III. Botany*, 1927, 1, 351-80, 7 pls., 13 figs.). Descriptions of the structure of three new genera of fossil tree-ferns found in Japan and Korea—*Cyathocaulis*, *Cibotiocaulis*, *Cyathorachis*—with a discussion of the affinities which they exhibit with the structure of living Cyatheaceæ. Numerous photographs of microscopic sections are given.

A. G.

Cyatheaceæ.—YUDZURU OGURA ("Comparative Anatomy of Japanese Cyatheaceæ," *Journ. Faculty of Science Imper. Univ., Tokyo, III. Botany*, 1927, 1, 141-350, 74 figs.). A detailed account of the anatomy of *Cyathea spinulosa* Wall., *Alsophila Ogura* Hayata, *A. acaulis* Mak., *A. Bongardiana* Mett., *Cibotium Barometz* Sm., and three species of *Alsophila* from Formosa and the Loochoo Islands, with a general summary giving a full account of the author's conclusions with regard to the structure of the Cyatheaceæ in stem, vascular system, stele, leaf trace, frond, root, bud.

A. G.

Polypodiaceous Stele.—YUDZURU OGURA ("On the Gaps in the Stele of some Polypodiaceæ," *Bot. Mag., Tokyo*, 1921, 35, 113-25, 4 figs.). An investigation of the stele in various polypodiaceous ferns of Japan. Most of the species have the fronds arranged all round the rhizome, though this would not always be revealed by the habit of the plant, and most of these species have a dictyostelic stele, and these may be grouped according to whether they have a $\frac{1}{2}$ or a $\frac{3}{4}$ phyllotaxy and according to the number of their foliar leaf traces, etc. The length of the gap varies directly with the length of the internode, so that the relation of two consecutive gaps in one and the same row and the commissure between them is constant. Dictyostely and solenostely in Polypodiaceæ are determined irrespective of the length of the internode, and chiefly by the length of the gap.

A. G.

Diplazium.—Y. OGURA ("On the Structure of *Diplazium esculentum* (Retz.) Sw.," *Bot. Mag., Tokyo*, 1927, **41**, 172–80, 4 figs.). The stem of *Diplazium esculentum* is dendroid and has a dictyostele with medullary bundles. The petiole has double bundles which fuse into one above. The construction of the stelar ring, the leaf traces, the sclerenchymatous masses, and the histology, are of the normal polypodiaceous type. The medullary bundles in the adult plant originate independently in the pith, while in the young plant they originate by internal thickening of the meristele. In both cases their upper ends join with the leaf traces.

A. G.

Key to Ferns.—C. E. WATERS ("An Analytical Key for the Ferns of the North-Eastern States, based on the Stipes," *Amer. Fern Journ.*, 1928, **18**, suppl., 1–14). The cross-sections of the stipes upon which this key is based were made a little above the base, the specimens being as mature as possible. The species are grouped according to the presence of 1, 2, 3, 4, 5, or more bundles, and are subdivided according to the shape and arrangement of the bundle as seen in section—round, flat, curved, etc., in rings or irregular, and descriptive notes of the frond, etc., are given.

A. G.

Ferns of Porto Rico.—WILLIAM R. MAXON ("Pteridophyta of Porto Rico and the Virgin Islands," *Scientific Survey of Porto Rico and the Virgin Islands*, 1926, **6**, Botany, pt. 3, 373–521). A systematic flora giving descriptions of all the ferns hitherto found in Porto Rico, with indication of their distribution in the other islands of the West Indies and on the main land. Keys to the genera and species are provided, and synonyms and citations are carefully stated.

A. G.

Jamaica Ferns.—WILLIAM R. MAXON ("New Tropical American Ferns—V," *Amer. Fern Journ.*, 1928, **18**, 46–51). Descriptions of three new species of Jamaica ferns—*Polypodium Randallii*, *P. exornans*, *Dryopteris Underwoodiana*. The first has been collected once only. The second is here carefully distinguished from *P. asplenifolium* L. (*P. suspensum* of several authors). The third is also critically distinguished from near allies.

A. G.

Bryophyta.

Carboniferous Bryophyta.—J. WALTON ("Carboniferous Bryophyta. II. Hepaticæ and Musci," *Ann. Bot.*, 1928, **42**, 707–16, 1 pl., 1 fig.). Descriptions are given of *Hepaticites metzgerioides* from the Shropshire coal-measures, *H. Willsi*, *H. Kidstoni*, *H. lobatus*, *H. Langi*. They are compared with some of the living anacrogynous Liverworts. *Muscites polytrichaceus* Ren. et Zeill. and *M. Bertrandi* Lign. are discussed, and a problematical fossil from Preesgweene, possibly a sporogonium, is described.

A. G.

Riccia Curtisii.—FREDERICK McALLISTER ("Sex Ratio and Chromosomes in *Riccia Curtisii*," *Bull. Torrey Bot. Club*, 1928, **55**, 1–10, 5 figs.). The adherent spore tetrads of this hepatic are compared with those of certain species of *Spharocarpus* which, when disseminated, give rise to four plants, two male and two female, and the work of previous authors is reviewed. Further investigations by the author are given, showing that *Riccia Curtisii* is strictly diceious. Attempts to prolong the life of the plants failed; also laboratory culture was a failure. The plants had to be grown in the field, and were quickly killed by drought. Young plants mature in two to three weeks, and female plants attain a larger size than the male. Observations show that the spore tetrads of *R. Curtisii* produce regularly two female and two male plants. The separation of the two sexes takes place

during the reduction divisions of the nuclei. The number of chromosomes in both male and female nuclei is eight. Nothing was found in *R. Curtisii* comparable with the X and Y chromosomes described for *Sphaerocarpus* by C. E. Allen. Such chromosome differences are not necessarily concerned with sex segregation.

A. G.

Mexican Mosses.—I. THÉRIOT ("Mexican Mosses collected by Brother Arsène Brouard," *Smithsonian Misc. Coll.*, 1926, 78, no. 2, 1-29, 14 figs.). The first report on the Mexican moss collections of Brother Arsène, who, previous to 1914, collected in the states of Puebla and Michoacán and gave his mosses to the U.S. National Museum at Washington. It contains about 70 species, 11 of which, with some varieties, are new to science. Several points of difficulty are cleared up in the critical notes. A second report (*op. cit.* 1928, 81, no. 1, 1-26, 9 figs.) contains 98 species, with descriptions of seven species and some varieties new to science, and numerous critical notes.

A. G.

Thallophyta.

Algae.

Plankton.—EINAR NAUMANN ("Zur Kritik des Planktonbegriffes," *Arkiv för Botanik*, 1927, 21A, no. 10, 1-18). A discussion of the conception of Plankton under the headings: Questions to be considered; phytoplankton in its dependence on a floating mode of life; its dependence on the zoological inhabitants of lakes; the colonisation of the plankton zone; physical hypothesis of the colonisation; survey of the problems.

A. G.

Plankton.—EINAR NAUMANN ("Über die Abhängigkeit des Phytoplankton typus vom Gewässertypus," *Arkiv för Botanik*, 1927, 21A, no. 11, 1-24, 1 fig.). A discussion of the relation of phytoplankton to its aquatic environment, and of the systems which have been founded on the physiognomy of the phytoplankton: (1) the standing water type defined by Chodat; (2) the further grouping devised by O. Zacharias; (3) older systems founded on the physical and chemical properties of the aquatic environment by Lemmermann and others; (4) present-day classification of the water environment from the point of view of regional limnology; (5) the change of eutrophic and oligotrophic plankton types under changing topographical conditions.

A. G.

Michigan Plankton.—SAMUEL EDDY ("The Plankton of Lake Michigan," *Illinois Nat. Hist. Survey Bull.*, 1927, 17, 203-32). A general account of the plankton of Lake Michigan, with a determination of the relative abundance of its constituent organisms, set out in tabular form and with a summary of what is known about the plankton of the Great Lakes. A comparison of the records made from year to year and from season to season shows the stability of the plankton of Lake Michigan and of the lake waters. Of species abundant 40 years ago only one is absent now. The seasonal collections reveal a fairly constant and uniform phytoplankton throughout the year, but the zooplankton varies somewhat with the season. Diatoms predominate at all times, constituting the majority of the organisms in all collections.

A. G.

Algal Food of Marine Animals.—JOSEPHINE E. TILDEN ("A Bibliography of the Literature dealing with the Algal Food of Marine Animals," *Journ. Pan-Pacific Research Institution, Honolulu*, 1927, 2, no. 2, 3-8). The plant food of sea animals consists of (1) floating plankton; (2) attached coastal algae, etc.;

(3) organic *débris* of plankton and algæ. The sub-littoral algal flora is very abundant and attracts many species of fishes, most of which hunt for their food near to the shore, and ultimately are dependent on algæ for their organic material. Many small reef fishes of Hawaii browse upon shore algæ. Pelagic animals, including the big blue whale, live on diatoms and other plankton. Scavenger animals devour the organic matter of the sea bottom. A list of nearly 120 papers relating to the subject is appended. A. G.

Algæ of Connecticut.—C. J. HYLANDER ("The Algæ of Connecticut," *Conn. Geol. and Nat. Hist. Survey Bull.*, 1928, 42, 1-245). A full enumeration of the freshwater algæ of Connecticut, without descriptions but with numerous keys. It is the result of a very careful study of the State, and the localities are all given under each species. The introduction contains a full account of the morphology and classification of the algæ. A. G.

Algæ of British Columbia.—WM. RANDOLPH TAYLOR ("The Alpine Algal Vegetation of the Mountains of British Columbia," *Proc. Acad. Nat. Sci., Philadelphia*, 1928, 80, 45-114, 5 pls., 3 figs.). The results of investigations carried on during several summers while camping in the mountains of British Columbia. The amount of apparatus employed had to be restricted to the minimum. The local conditions of the collecting grounds are described and their algal flora enumerated. Comparison is made with the flora of other countries. A systematic list is given of all the species that have been definitely determined, including some new species and varieties. In all, there are about 160 species and several varieties. A. G.

Coleochæte.—OPHELIA C. WESLEY ("Asexual Reproduction in *Coleochæte*," *Bot. Gaz.*, 1928, 86, 1-31, 2 pls., 41 figs.). An account of the production of zoospores in four species of *Coleochæte*, the formation of the spores and their escape, the development of a new plant body out of the resting spore, the development of hairs and of holdfasts, regeneration of the thallus after injury. Other stages in the life-history of the genus are to be published later on. A. G.

Reproduction in *Caulerpa*.—RODOLPHE DOSTÁL ("Sur les organes reproducteurs de *Caulerpa prolifera*," *Compt. rend. Acad. Sci., Paris*, 1928, 187, 569-70). The reproduction of *Caulerpa*, hitherto unknown, is described from observations made at Villefranche-sur-mer during August-September, 1927, and in the present year. The formation of the reproductive organs is brief in its period and rare in its occurrence, being seen on but 5 p.c. of the plants of *C. prolifera* examined. The fertile plants are characterised by the presence of small papillæ on the surface of the fronds. The papillæ are preceded by small white spots, and measure 1.0×0.1 mm. Soon the stolons lose colour and the fronds exhibit a fine green protoplasmic network, the papillæ extrude a small portion of their contents, the fronds lose their turgescence, and, as they wither, dark green spots become visible, owing to the massing together of the spores. The spores are set free by the rapid decay of the plant; they are $4-5 \mu$ long, pyriform, biciliate, and contain an asymmetric chloroplast and a pigment spot. The cilia are two to two and a half times as long as the spore. They move actively and do not copulate. They are to be regarded as zoospores. The stolon plays an important part in the reproductive process. A. G.

Antheridia of Characæ.—JOHN S. KARLING ("Nuclear and Cell Division in the Antheridial Filaments of the Characæ," *Bull. Torrey Bot. Club*, 1928, 55, 11-39, 1 pl.). The author gives a summary of numerous papers which describe

synchronous or simultaneous nuclear division in plants and animals, and divides this simultaneity of division into complete synchronism, common in sporangia, antheridia, oogonia, asci and basidia, and progressive synchronism where the nuclei, as in embryo sacs, are in successive stages of division. In the antheridial filaments of the Characeæ there is a high degree of synchronism in the nuclei of adjoining cells, either complete throughout the filament or progressive for longer or shorter distances by linear groups of cells. He then describes his own observations in detail and tabulates the results. Finally he discusses at some length the interpretation of the details shown in his photographs of antheridial filaments of *Nitella* and *Chara* undergoing nuclear division. A. G.

New Zealand Bangiales.—ROBT. M. LAING ("New Zealand Bangiales, *Bangia*, *Porphyra*, *Erythrotrichia* and (?) *Erythrocladia*," *Trans. New Zealand Inst.*, 1928, 59, 33-59, pls. 1-15). A revision of the New Zealand species of *Bangia*, *Porphyra*, *Erythrotrichia*, *Erythrocladia*. Determinations made by authors in the past have caused much perplexity. The species found in New Zealand, as arranged by Mr. Laing after much investigation, are as follows:—*Bangia fusco-purpurea* (Dillw.) Lyngby, *Porphyra columbina* Mont., *P. umbilicalis* J. Ag. var. *Novæ Zelandiæ* Laing, *P. subtumens* J. Ag. et Laing, *Erythrocladia insignis* Laing, *Erythrotrichia ciliaris* (?) Carm. (Batters). The structure of these is described in detail, and their affinities are critically discussed. *Porphyra columbina* includes *P. nobilis* J. Ag. *Erythrocladia insignis* grows upon *P. umbilicalis* var. *Novæ Zelandiæ*, and is a case of antagonistic commensalism. A. G.

Algæ of Naples.—GEORG FUNK ("Die Algenvegetation des Golfs von Neapel nach neueren ökologischen Untersuchungen," *Pubbl. della Stazione Zoologica di Napoli*, 1927, 7, suppl., 1-507, 20 pls., 50 figs.). An intensive study of the algal vegetation of the Gulf of Naples, begun in 1913 and interrupted by the Great War. In part I the algæ collected at numerous localities along the coast are recorded, and those dredged from shallow, moderate and great depths. Part II treats of the distribution of marine algæ in the gulf, their substrata, their formations and associations, their periodicity. Part III is a systematic account of all the algæ observed in the Gulf of Naples up till 1925, with numerous photographic figures. A. G.

Japanese Algæ.—YUKIO YAMADA ("Report of the Biological Survey of Mutsu Bay. 9. Marine Algæ of Mutsu Bay and Adjacent Waters. II," *Science Reports Tôhoku Imp. Univ., Fourth Series (Biology)*, Sendai, 1928, 3, no. 4, 497-534, 25 figs.). A list of 51 species, which raises the known flora of Mutsu Bay to 86 species. There are 7 green, 18 brown, and 26 red algæ, several with descriptive notes and figures; 12 are additions to the Japanese flora, and 6 of these are new to science. A. G.

Vitamins from Algæ.—JOSEPHINE E. TILDEN ("Our Richest Source of Vitamins. Down to the Sea for Seaweed maybe the Next Step in Replacing our Disappearing Sources of Food Supplies," *Scientific American*, Feb., 1928, 114-71, 10 figs.). A popular account of the nature of vitamins and their need in the animal economy. Animals cannot manufacture vitamins as green plants do, but acquire them from plants. Cod-liver oil contains vitamins A and D and iodine. Algæ contain all the vitamins, especially A, and absorb iodine from sea-water, the kelp algæ being particularly rich in this element. The Japanese and Chinese make great use of algæ as food, as also did the people of Hawaii and Tahiti in former years. Several figures are given which show the seaweed industries of Japan. A. G.

Karyokinesis in Cystophyllum.—NAOMASA SHIMOTOMAI ("Karyokinese im Oogonium von Cystophyllum sisymbryoides J. Ag.," *Science Reports Tōhoku Imp. Univ., Fourth Series (Biology)*, Sendai, 1928, 3, no. 4, 577-9, 2 figs.). An account of the karyokinesis observed in the oogonium of *Cystophyllum sisymbryoides* J. Ag., a brown alga widely distributed on the coasts of Japan. The details of nuclear division are described. The number of haploid chromosomes is 32.

A. G.

Egregia.—MARGRET E. MYERS ("The Life-History of the Brown Alga *Egregia Menziesii*," *Univ. Calif. Publ. Bot.*, 1928, 14, no. 6, 225-46, 4 pls.). A posthumous thesis on the life-history of *Egregia Menziesii*, one of the large kelp algæ of N.W. America. Like other laminariaceous algæ, *Egregia* is shown to have a definite alternation of generations. The macroscopic plant is the sporophyte, with diploid nuclei containing 16 chromosomes, the reduction division being the first division in the sporangium. The gametophyte generation is microscopic, the female plant consisting of one to two (rarely four) cells, and the male of two to four vegetative cells and as many as a dozen antheridial cells. The morphology and cytology of these inconspicuous gametophytes are described and represented by numerous figures. Gametes were emitted at temperatures ranging from 10° to 16° C., but temperatures from 16° to 20° C. prevented the antheridia from being liberated. The first four to five walls of the young sporophytes are transverse. Then longitudinal walls appear, and rhizoids which are negatively phototropic.

A. G.

Potassium and Sodium in Marine Algæ.—GABRIEL BERTRAND and M. ROSENBLATT ("Le potassium et le sodium dans les algues marines," *Compt. Rend. Acad. Sci., Paris*, 1928, 187, 266-70). A report on analyses of 11 species of brown algæ to determine the percentage of sodium and of potassium in each. Four species of *Fucus*, two of *Laminaria*, and one each of *Ascophyllum*, *Pelvetia*, *Cystoseira*, *Himantalia* and *Padina* were investigated. The results are tabulated, and show that potassium and sodium are present in all these algæ. Marine algæ differ in their sensitivity to the action of fresh water. *Pelvetia* can withstand repeated washing with fresh water without losing its internal salts, whereas *Padina* is soon robbed of its alkaline salts. This suggests an explanation as to why some algæ can tolerate exposure at low tide and the action of rain better than others. Usually the amount of sodium does not exceed that of potassium. It should be noted that when algæ are placed in a solution containing, say, 28 times as much sodium as potassium, they do not absorb the alkaline salts according to this ratio, but display a selective absorption which results in an accumulation of potassium within the alga at a far higher ratio. This is a phenomenon that requires further investigation.

A. G.

Fungi.

Phytophthora on Seedlings.—FELICIANO M. CLARA ("A Phytophthora Disease of Santol Seedlings," *Philipp. Journ. Sci.*, 1928, 35, 411-25, 4 pls., 4 text figs.). The fungus was noted in seed beds at the Singalong Experiment Station, Manila. It formed blights on different parts of the young seedlings, of which it destroyed about 90 p.c. and also infected a neighbouring seed-bed of Para rubber plants. The fungus, which is described in the different stages of attack, was finally identified as *Phytophthora infestans*, hitherto unknown in the Philippine Islands. The disease may be prevented by planting seeds in sterilised soil, and also by spraying with lime-sulphur or Bordeaux mixture.

A. L. S.

New Species of *Olpidium*.—E. J. SCHWARTZ and W. R. IVIMEY COOK ("The Life-History and Cytology of a New Series of *Olpidium*—*Olpidium radiale* sp. nov.," *Trans. Brit. Mycol. Soc.*, 1928, 13, 203-21, 3 pls.). The parasitic fungus was found in the roots of *Veronica Beccabunga* growing in low-lying meadows. No other plant was attacked, though in certain conditions infection may occur. A large quantity of infected roots in various stages of development were secured, and examination was made both of living and of fixed material. The life-history and cytology were successfully followed. Zoosporangia are produced, some after nuclear fusion, others without fusion. The zoospores are liberated and pass into other host-cells, or they enter the epidermal cells of the root. Nuclear division is always mitotic. A description is given of the new species. A. L. S.

***Olpidium radiculolum* de Wildeman.**—A. W. BARTLETT ("*Olpidium radiculolum* de Wilde. and the 'Hybridisation Nodules' of Swedes," *Trans. Brit. Mycol. Soc.*, 1928, 13, 221-38, 2 pls.). Bartlett gives first an account of the various outgrowths that are formed on the roots of swedes and other *Brassicæ*. The nodules on swedes have not been considered as associated with parasitic growths; they tend to become green when exposed to the light, and sometimes bear adventitious shoots and leaves. In the roots of nodulose swedes a Chytridiaceous parasite has been constantly found, described as *Olpidium radiculolum*. An account of the parasite is given by Bartlett, who has observed both temporary and resting sporangia as well as the escape of the zoospores. The fungus may be very destructive to seedling plants of swede and turnip, also occasionally to cabbage. It is held that the presence of the fungus may induce the growth of the nodules. It has not been proved that nodules ever appear in ground entirely free from the fungus. A. L. S.

Rare Mucoracea.—B. PEYRONEL ("Una rara mucoracea parassita e le affinità naturali di alcuni funghi a cappello," *Nuovo Giorn. Bot. Ital.*, 1928, 34, 1267-74). The mould *Dicranophora fulva* is a rare parasite of the common fungus *Paxillus involutus*. Peyronel reports a somewhat similar form on *Boletus elegans* and other *Boleti* in the Torino. It has also been recorded as growing on *Gomphidius viscidus*. An account of the truly parasitic nature of the fungus is given, and an inquiry into the affinities of the different host plants. A. L. S.

Studies on the Biochemical Differences between Sexes in Mucors.—SOPHIA SATINA and A. F. BLAKESLEE (*Proc. Nat. Acad. Sci.*, 1928, 14, 229-35). In this paper the authors record their tests as to the "Enzymes which act upon Carbohydrates and their Derivatives." The aim was to discover, if any, the biochemical differences between the sexes—the (+) and (−) strains—in mucors. Cultures were made of 10 species and 8 genera of mucors in order to examine their reaction to different culture media. Glucose was used as a control medium. No qualitative difference was discovered, though differences existed between species in the amounts and nature of the enzymes present. Among the forms tested, *Cunninghamella* appeared to contain the greatest number of carbohydrases, species of the genera *Mucor* and *Pezizella* the fewest. Trehalase, maltase and emulsin were present in all the species, sucrase and inulase in races of two species only. In a further paper (*ibid.* 308-16) the authors give an account of the examination of the "Quantitative Determinations of Sugars in (+) and (−) Races." In a summary they state that determinations were made in pairs (+ and −). Reducing sugars were present in 70 (+) and (−) races, non-reducing sugars in 60 (+) and (−) races. In the majority of species tested, more sugar was found

in the (+) than in the (—) races, and the average for (+) races was higher for all kinds of sugar. Other substances, possibly related to the tannins, may be the main cause of the evident differences in reduction capacity of (+) and (—) races. Experiments were also made as to fat content, but conditions of growth had so much influence on the quantity of fat that conclusions were difficult. Finally it is stated that the relative amounts of sugars in (+) and (—) races are considered to be significant.

A. L. S.

New Genus of Endomycetaceæ.—G. NADSON and N. KRASSILNIKOV ("Un nouveau genre d'Endomycétacées—Guillermondella," *Compt. Rend. Acad. Sci.*, 1928, 187, 307–9, 1 text-fig.). The new fungus was discovered in the gummy substance excreted from oaks at Kalonga (U.S.S.R.). The authors describe the development of the fungus as followed by them on artificial cultures—the formation of mycelium and yeast cells and the formation of asci on the mycelium or by transformation of the yeast cells. Asci arise either parthenogenetically or may be preceded by a sexual copulation. The ascus contains four spores. This fungus did not cause fermentation in any of the sugars tested; it slowly lignified gelatine. The mycelium develops well in anaerobic conditions, but no asci form.

A. L. S.

Italian Tuberaceæ.—G. MATTIROLO ("Secondo elenco der 'Fungi Hypogæi' raccolti nelle Foreste di Vallombrosa (1900–28)," *Nuovo Giorn. Bot. Ital.*, 1928, 34, 1343–58). A previous contribution on this subject was published by Mattiolo in 1900. The number of species recorded has been largely increased by the continued research of the author, who now publishes the new material. He had added a genus and species new to science, *Fischerula macrospora*, distinguished from other members of the family by the size and character of the ascospores. The new tuber was found, not only in Vallombrosa, but in other localities.

A. L. S.

Study of Ceratostomella.—H. A. DADE ("Ceratostomella paradoxa, the Perfect Stage of *Thielaviopsis paradoxa* (de Seynes) Von Höhnelt," *Trans. Brit. Mycol. Soc.*, 1928, 13, 184–94, 3 pls.) *Thielaviopsis paradoxa*, a conidial form, is well known in the tropics as a disease of sugar-cane, pineapples, and coconut palms. Various suggestions have been made as to associated stages. By careful cultural experiments the author has at length produced the perfect stage, which he has identified as a *Ceratostomella*. A condition of heterothallism was surmised from the failure of single-spored cultures to produce anything save the conidial forms, growths from the same strains producing only mycelial mats with aerial conidia. From different strains a regular growth of perithecia was obtained, proving the heterothallic nature of the fungus. The perithecia have the characteristic beaks and spores of *Ceratostomella*.

A. L. S.

Biologic Studies in the Sphæriales, I.—JULIAN H. MILLER (*Mycologia*, 1928, 20, 187–213, 2 pls., 3 text-figs.). In the Sphæriales as at present understood the perithecia are hard, carbonaceous or leathery and without an accompanying stroma. The term "stroma," as used by the writer, is a fungous body formed of coalesced hyphæ which does not arise as a result of sexual stimulus. Examples are given in which the outer wall of the perithecium is not stromatic, and arises as a result of sexual fusion. Not only the perithecial wall, but the ostiole and the paraphyses are discussed, more especially with regard to their origin: the paraphyses arise from the ascial layer, as in the Diaporthæ; in other groups they arise from the perithecial membrane. Comparison of the development in Dothideales

and Sphaeriales is dwelt on, the fundamental point of difference being the perithecial wall-formation. In Dothideales the asci develop from a convex placenta, and at maturity the stroma disintegrates to form an opening for the escape of the spores. That is not true perithecial formation, and the orders and families with similar developments are, therefore, not true Pyrenomycetes.

A. L. S.

Study of Englerulaceæ.—F. PETRAK ("Ueber Englerula und der Englerulaceen," *Ann. Mycol.*, 1928, 26, 385–413). The family Englerulaceæ was based by Hennings on the genus *Englerula* described by him in *Hedwigia* (1904). Petrak has made a study of 17 genera included in the family. He has given descriptions of these and reasons for rejecting some. The main characteristic of all is the lack of structure in the peridium. They are related to the Perisporaceæ and Hypocreaceæ, but are quite distinct.

A. L. S.

Further Studies of the Brown-Rot Fungi.—H. WORMALD (*Trans. Brit. Mycol. Soc.*, 1928, 13, 194–204). The subject has already been discussed by Honey, who placed the American brown-rot fungus in a new genus *Moniliana*. Wormald has given a survey of American literature, as it is with the American brown rot that he is chiefly concerned. It is evidently proved to be a distinct species, *Sclerotinia americana*. It has been confused with *S. cinerea* and *S. fructigena*, which represent the brown rots of Europe.

A. L. S.

Polish Laboulbeniaceæ.—JANINA I WINCENTY SIEMASZKO ("Owadorosty polskie i palearktyczne," *Polskie Pismo Entomologiczne, Bull. Entom., Pologne*, 1928, 6, 188–211, 1 pl., Polish with English summary). The paper—the first record of Laboulbeniales in Poland—deals with native species found by the authors and also with those found in foreign collections of insects. The list comprises 41 species and 7 varieties. Of these, 35 species belong to the flora of Poland, 5 being new to science.

A. L. S.

Study of Yeast Cells.—OSCAR W. RICHARDS ("Changes in Sizes of Yeast Cells During Multiplication," *Bot. Gaz.*, 1928, 86, 93–101, 5 text-figs.). The writer has studied the growth of yeast cells in nutrient fluid. The variations in size of the cells has been a puzzle. Richards finds that the changes follow a definite cycle which is associated with the accumulation of toxic excretion products in the culture medium. When the medium is kept effectively constant, the cycle does not occur; the changes are due to environment. Also he found that bud formation was independent of the size of the mother-cell, and seemed to be determined by the physiological condition of the budding cell.

A. L. S.

New or Rare British Discomycetes.—CARLETON REA (*Trans. Brit. Mycol. Soc.*, 1928, 13, 253–60). Rea publishes the descriptions of a large number of fungi belonging to widely separated genera of Discomycetes. Most of them were already known on the continent; a few are new to science. They have been sent to Rea from collectors in many parts of the country. Some have been found in several districts.

A. L. S.

Studies of Phyllachoræ.—FRED J. SEAVER ("Studies in Tropical Ascomycetes. V. Species of Phyllachora," *Mycologia*, 1928, 20, 214–25, 6 pls.). Most of the species discussed were collected from the central regions of the Western Continent. In northern countries the fungus is known generally as a parasite on monocotyledons—grasses, sedges, etc. Seaver records species on many Dicotyledons. The stromata of the fungus occur on leaves and take different forms. The species are fully described and the paper is richly illustrated.

A. L. S.

Unisexual Conidia from Bisexual Mycelia.—B. O. DODGE (*Mycologia*, 1928, 20, 226–34, 1 text-fig.). Dodge has worked with the material of his previous experiments, the homothallic (bisexual) *Neurospora tetrasperma*. By cultures he established that from the mycelium of that species were produced, not only bisexual conidia, but also some unisexual conidia. If the cultures were from two mixed heterothallic mycelia, there was no evidence that bisexual conidia were developed.

A. L. S.

Study of Colletotrichum.—MAUD M. DUKE ("The Genera *Vermicularia* and *Colletotrichum* Cke.," *Trans. Brit. Mycol. Soc.*, 1928, 13, 156–82, 1 pl. 11 text-figs.). Both of these genera were founded on one species. The first, *Vermicularia*, was wrongly described, and it is proposed to retain the more accurately understood *Colletotrichum*. The genus is characterised by an innate acervulus that bears conidiophores with terminal conidia and also dark brown setæ. The two genera are thoroughly discussed by the author, and British species are described under *Colletotrichum*, which necessitates new combinations in several cases. Several new species are added. The fungi are parasitic on leaves and stems.

A. L. S.

Californian Fungi.—LEE BONAR ("Studies on Some Californian Fungi," *Mycologia*, 1928, 20, 292–7, 2 text-figs.). Bonar has published the result of cultural and field studies on a number of microfungi. Thus for a species of *Lasiobotrys* he gives the development of the perithecium and ascospores and also of the conidial stage. Critical studies of other species are given, and descriptions of two new to science. In a second section of the paper he gives an account of the genus *Harknessia*. The original type of the genus *H. Eucalypti* Cooke and Hark. was described from material collected in California, and later was classified by Von Höhnel in the Melanconiales. Bonar describes a new genus *Disceta* in which the brown four-septate spores have a hyaline bristle at each end.

A. L. S.

New Species of Imperfect Fungi.—JOHN DEARNESS ("New and Noteworthy Fungi. V. Deuteromycetes," *Mycologia*, 1928, 20, 235–46). The fungi described are nearly all new to science, and are from N. America, from regions as diverse as Winnipeg and Florida. Most of them belong to the Sphærospidales, a few to Melanconiales. They are presumably all parasitic, though a few, such as *Leptostromella Cassia*, are recorded only from dead stems.

A. L. S.

Discussion of Phoma Species.—MALCOLM WILSON and GLENN GARDNER HAHN ("The Identity of *Phoma pitya* Sacc., *Phoma abietina* Hark., and Their Relation to *Phomopsis pseudotsugæ* Wilson," *Trans. Brit. Mycol. Soc.*, 1928, 13, 261–78, 4 pls.). The authors have cleared up the confusion regarding these three fungi found on conifers. They find that they are distinct species, but that *Phoma pitya*, probably a saprophyte, should be relegated to the genus *Sclerophoma* and should be known as *Scler. Magnusiana*; that *Phoma abietina* is a *Phomopsis* which does not occur in Britain. *Phomopsis Pseudotsugæ* differs in several respects. It is a true parasite, and kills the young shoots, etc., of Douglas fir.

A. L. S.

Study of Phomopsis.—GLENN GARDNER HAHN ("*Phomopsis conorum*, (Sacc.) Died., an old Fungus of the Douglas Fir and Other Conifers," *Trans. Brit. Mycol. Soc.*, 1928, 13, 278–86, 2 pls.). Reference is made to the work of the above paper on *Phoma* species. *Phomopsis conorum* is a parasite on the shoots of Douglas fir, and must not be confused with *Ph. pseudotsugæ*. Hahn has made a thorough study of both species. *Ph. conorum* is only a saprophyte, and differs from *Ph. pseudotsugæ* "both morphologically and physiologically."

A. L. S.

Species of Phyllosticta on Ornamental Plants.—G. NICOLAS and Mlle. AGGÉRY ("Notes sur deux phyllosticta parasites de plantes ornementales," *Bull. Soc. Mycol. France*, 1928, 44, 210–14, 2 text-figs.). The parasites appeared on the leaves of *Daphniphyllum glaucescens* and *Ficus elastica* in the Botanic Garden, Toulouse. Discoloured spots appeared on the leaves, and the pycnidia were observed and their development studied. In both cases they have been determined as new species. A. L. S.

Fungi on Agave americana.—G. NICOLAS and Mlle. AGGÉRY ("Observations sur deux champignons de l'*Agave americana* L.," *tom. cit.* 215–16). Dried and discoloured spots were noted on the leaves of Agave in the Pyrénées-Orientales, due to a fungus which gradually killed the leaf. It was finally determined as *Coniothyrium concentricum* var. *agaves* previously reported from Italy, Portugal, and Austria. An associated fungus, *Stagonospora macrospora*, was also noted as saprophytic on the dead tissues. A. L. S.

Notes on Uredineæ.—H. SYDOW ("Notizen über einige in letzter Zeit neu beschriebene Uredineen," *Ann. Mycol.*, 1928, 26, 447–9). Sydow has been able to examine a number of species recently described, and has found the diagnoses somewhat faulty. Reasons are given why he considers the species to be wrongly described or wrongly determined. A. L. S.

Cultures of Uredineæ.—ALFRED HASLER ("Kulturversuche mit zwei Uredineen," *Ann. Mycol.*, 1928, 26, 453). Hasler has established the relationship of two species. *Æcidium Circœæ*, of which the æcidium form alone was known, was successfully grown on several forms of *Carex*, and formed the *Puccinia* stage in the life-cycle. Teleutospores from *Carex lasiocarpa* produced æcidia on *Ribes nigrum*, but not on other *Ribes* species. A. L. S.

Polyporaceæ of Bengal, VIII and IX.—S. R. BOSE (*Journ. Dept. Sci.*, 1928, 9, 27–33, 35–44, 10 pls.). In each of these two contributions Bose describes 12 species belonging to the genera *Polyporus*, *Polystictus*, *Fomes*, *Poria*, *Lenzites* and *Dædalea*. All the fungi enumerated had already been published, but Bose from fresh collections has added many notes as to habitat and distribution, and careful details as to microscopic structure. Photographic plates are given of all the species. A. L. S.

Tropical Root Disease Fungi.—T. PETCH (*Trans. Brit. Mycol. Soc.*, 1928, 13, 239–53). There has been considerable confusion as to the identity of fungi attacking roots in various countries. Petch has made an exhaustive examination of several of these. A prevalent root disease in Europe is due to *Armillaria mellea*, and disease has been attributed to it in Ceylon. Petch had decided the fungus in question was *A. fuscipes*, which is the tropical analogue of *A. mellea*. Another doubtful parasite is *Ustilina zonata*, reckoned by Petch to be the tropical form of *U. vulgaris*. Red root diseases are discussed, and Petch includes five fungi as causing these diseases. Finally he examines the identity of several *Polypori* which have been named as the cause of rubber root disease. A. L. S.

Study of Gasteromycetes.—W. C. COKER and J. NATHANIEL COUCH ("The Gasteromycetes of the Eastern United States and Canada," *Univ. of N. Carolina Press, Chapel Hill, N.C.*, 1928, 201 pp., 123 pls.). A systematic account of this large group. Eleven families have been dealt with in sequence, to which an artificial key has been provided at the beginning of the book. A full account is given of genera and species, their occurrence and habitat, and biological notes are added as well as discussions on taxonomy. The literature of the subject is given, either

as regards each family or in a final general list. The plates are numerous and give the natural appearance of the plants, microscopic details of spores, hyphæ, etc. An instance is given of a giant puff-ball, *Calvatia maxima*, that measured 5 ft. 4 in. by 4 ft. 6 in., and estimated to contain seven trillion spores. A. L. S.

Study of *Laternea triscapa*.—DAVID H. LINDER ("Concerning the Status of the Genus *Laternea*," *Ann. Miss. Bot. Garden*, 1928, 15, 109-12, 1 pl.). The genus *Laternea* was established by Turpin in 1822 with the species *L. triscapa*. C. G. Lloyd transferred to *Laternea* the species usually placed in *Clathrus*. Linder has compared the different forms and gives reasons for retaining *Laternea* as a good genus. In *Clathrus* the inner surface of the columns that form the receptacle are rough and pitted; in *Laternea* the columns are stipes united above. *Laternea* remains monotypic, and the species placed by Lloyd under the genus are referred by Linder to *Clathrus*. The fungus was collected by Linder in Cuba. A. L. S.

Notes on Classification of Fungi.—MAURICE SAUGER ("Etude sur les difficultés de la classification des champignons," *Bull. Soc. Mycol. France*, 1928, 44, 94-102). The author points out the difficulty of gaining common consent to systems of classification, especially of Basidiomycetes. A main difficulty is the absence of dominating characters. The most ancient classification was that of comestible and non-comestible. The system of Fries is based on morphology, but leaves out histology and spore characters. Modern classifications tend to neglect external morphology. For the present it is impossible to present a natural system that would be acceptable to all students. A. L. S.

***Russula Sardonica*.**—V. MELZER and J. ZOARA (*Bull. Soc. Mycol. France*, 1928, 44, 190-3, 1 col.-pl.). The authors trace the specific name to the Greek name Sardonion, a poisonous plant. They describe the various characteristics of the *Russula* and of the different forms. They all give a purple stain on the application of ammonia, a reaction that is more intense in pale or whitish specimens, but disappears in the herbarium. A. L. S.

Projection of Spores in an Agaric.—M. JOSSEMAND ("Projection de spores chez un agaricacée," *Bull. Soc. Mycol. France*, 1928, 44, 208-9, 1 text-fig.). It is generally understood that the spores of Hymenomycetes are liberated but not projected as in the Ascomycetes. Jossemand observed the phenomenon of projection in *Collybia clavus*, which was protected from all air currents and in which the spores were projected to a distance of 80 mm. on both sides of the plant. A. L. S.

Notes on *Amanita*.—E. GILBERT ("Notules sur les amanites," *Bull. Soc. Mycol. France*, 1928, 44, 155-69). Gilbert has taken occasion to criticise certain determinations of the larger Agarics made by Barla in his study of the fungi of the Alpes Maritimes. A considerable number of the plates are reviewed. Descriptions are given in detail of several species, and a full list of the synonymy of each. There are eight such citations of synonyms under *Limacella furnacea*. Gilbert concludes that probably a third of the species described are non-existent. A. L. S.

Notes on *Inocybe*.—J. BOURSIER and R. KÜHNER ("Notes sur le genre *Inocybe*," *Bull. Soc. Mycol. France*, 1928, 44, 170-89, 9 text-figs.). In this paper the authors have reviewed the species of *Inocybe* with rough spores (spores bosselées). They divide them into two groups: (1) *Cortinatae*, those with a cortina at an early stage, and (2) *Marginatae*, in which the stalk is bulbous-marginate at the base. Only the first group is dealt with, and a critical study is given of the different species, nine in all. A. L. S.

Research on the Spores of Agarics.—E. GILBERT and R. KÜHNER ("Recherches sur les spores des amanites," *Bull. Soc. Mycol. France*, 1928, 44, 149-54). The authors have applied the test of staining the spores of *Amanita* species with iodine. They give a complete list of those in which the spores stain blue in iodine solution, and those that show no reaction. They make several claims as to the value of this method in determination—that it alters the grouping of species and that it supersedes to some extent the consideration of the "veil" as a sound generic character. Hence they would do away with the genus *Amanitopsis*. They consider that the method of spore staining may be of assistance in determining poisonous species. They have also noted that in species with a striate edge to the pileus there is no reaction of spores to the staining fluid.

A. L. S.

Toxicity of Inocybes.—B. WIKI ("Nouvelles recherches sur la toxicité des inocybes," *Bull. Soc. Mycol. Genève*, 1928, 11, 14-18). Tests that were made with eight species of *Inocybe* have been renewed, and in all but one, *Inocybe Mimosa*, have yielded the results previously obtained; they contained muscarin, a toxic substance. Several species considered innocuous were proved also to contain the poisonous principle. Cooked specimens were fed to frogs and the action on the heart observed. Wiki sums up that eleven species had a strong muscarine action, three only after a strong dose; three were inconstant, and eight species were wholly inactive.

A. L. S.

Toxicity of Marasmius.—B. WIKI ("Note sur la toxicité de *Marasmius urens*," *tom. cit.* 17-18). Wiki has considered the species as synonymous with *M. peronatus*. British authorities keep them distinct. The species *M. urens* has an acrid taste, and is generally looked on as suspicious. Experiments were made on animals, and it was found that while the fungus contained muscarin, it was in very small quantities, and could have no harmful effect on human beings.

A. L. S.

Toxicity of Amanitæ.—B. WIKI ("Sur la non toxicité de l'*Amanita citrina* (Sch.) mappa (Batsch) Fr.," *Bull. Soc. Mycol. Genève*, 1928, 44, 19-22). Cases of poisoning have been attributed to *Amanita mappa* (*A. citrina*). Wiki has made tests on such animals as hare, cat, etc., and has concluded from his results that the fungus in question is non-toxic, and that any case of harm is due to an intermixture of *Amanita phalloides*. There is always risk of mistaking one *Amanita* for another. In any case, *Amanita citrina* has a disagreeable taste, and may well be considered as non-comestible.

A. L. S.

Case of Poisoning by Amanita phalloides.—JOACHIM GODINA ("Empoisonnement collectif par l'*Amanita phalloides*," *Bull. Soc. Mycol. France*, 1928, 44, 217-20). Godina describes a case in which several members of a family were fatally poisoned. One of the persons survived a month. The action of phalline on the blood is discussed.

A. L. S.

British Mycology.—E. WAKEFIELD ("Marlborough Foray and Aviemore Foray," *Trans. Brit. Mycol. Soc.*, 1928, 13, 145-9 and 305-11). The first of the forays was held in spring, when Savernake Wood and the neighbourhood of Marlborough were explored. As is usual in spring forays, the larger fungi were scarce, though a fair number were found. The smaller ascomycetes and microscopic forms were abundant. At Aviemore the main collecting was done in Rothiemurchus Forest, and a large number of the more northern larger fungi were found. Abernethy Forest was also explored. It was not so rich in large species, but microfungi were abundant and of unusual interest. A very long list is recorded.

A. L. S.

New or Rare Forest Fungi.—MALCOLM WILSON and JOHN S. L. WALDIE (*tom. cit.* 151-6, 1 pl.). The fungi discussed occur on conifers and are mostly saprophytes, though some may become parasites. *Rhizosphæra Pini* (Sphærospidiaceæ) is new to Britain, and in association with it *Adelopus balsamicola* (Sphæriaceæ), also new to this country. *Toxosporium camptospermum* and *Menoidea Abietis*, both on *Abies*, were collected in Argyle, both of them presumably parasitic. Full descriptions are given of all the species. A. L. S.

Temperature Tests for Fungi.—WALTER H. SNELL, W. G. HUTCHINSON, and K. H. N. NEWTON ("Temperature and Moisture Relations of *Fomes roseus* and *Trametes subrosea*," *Mycologia*, 1928, 20, 276-91, 1 pl., 2 text figs.). These two rose-coloured fungi have been considered as nearly related, and that any morphological differences were merely due to accidents or variations of growth. Heat has been applied to the mycelium of these and other similarly related species, such as *Lenzites sepiaria* and *Trametes protracta*. The writers have found that differences are very marked in the rate of growth at similar stages of temperature, and the tests were found to be safe and trustworthy. Full details are given as to methods of experiment by which the differences between the fungi were judged to be specific. A. L. S.

Histologic Changes in Diseased Leaves.—H. S. CUNNINGHAM ("A Study of the Histologic Changes Induced in Leaves by Certain Leaf-Spotting Fungi," *Phytopathology*, 1928, 18, 717-51, 10 text-figs.). The paper represents some of the work done during an investigation on the pathological histology of leaf lesions. A large number of diseased leaves from different trees, and caused by a variety of parasitic fungi, were studied. Injuries due to mechanical action were also examined. In many cases a definite meristem arises from the leaf-cells and forms a cicatrice round the edge of the lesion. These cells often become filled with dark granular matter and evidently hamper the advance of the fungus. In other cases the cells round the edge of a wound are merely dead and collapsed. Again, he found in *Ampelopsis tricuspidata* that while diseased leaves form no cicatrice round the wound, a periderm was formed round the edges of a mechanical injury. All plants that produced a cicatrice round a fungus necrosis, however, also formed a cicatrice round a mere injury. The conditions of the leaf tissues and especially of the cells neighbouring the wounds have been carefully examined and described. A. L. S.

Micromycetes Philippinenses.—H. SYDOW and F. PETRAK (*Ann. Mycol.*, 1928, 26, 414-46). The fungi here listed were collected by Mary Strong Clemens in various provinces of the Philippines. A very large number are recorded—Uredineæ, Ustilagineæ, Pyrenomycetes and Sphærospidiæ. Many new species are described in each of these groups. One new genus is recorded by Sydow, *Achrotelium*, a member of the Colesporiaceæ. The paper is a first instalment, as the collection is a very large one. A. L. S.

African Fungi.—R. MAIRE ("Diagnoses de champignons inédits de l'Afrique du Nord," *Bull. Soc. Mycol. France*, 1928, 44, 37-56, 5 pls.). The fungi described are mostly members of the Agaricaceæ, and have been collected by the author in and around Algiers. There is only one parasitic species recorded, *Physoderma Ornithogali*, closely allied to *Cladochytrium*. The paper is enriched by five coloured plates. A. L. S.

Fungi of Auvergne.—M. and MME. FERNAND MOREAU ("Observations mycologiques en Auvergne en 1927," *Bull. Soc. Mycol. France*, 1928, 44, 69-78),

The authors find for the mountainous region of Central France a large and varied fungus-flora. They have listed a large number of the large species, with notes as to the different habitats and of their seasonal occurrence. More detailed notes are given of a certain number with reference to their ecology, etc. A. L. S.

Fungi of the Dominican Republic.—ROMUALDO GONZALEZ FRAGOSO and RAFAEL CIFERRI ("Hongos parasitos y saprofitos de la republica dominicana," *Estación Agronom. de Moca, Ser. B., Bot., Santo Domingo, R.D.*, 1927, nos. 6-10, 1-99, 45 text-figs.). We have here a reproduction of papers previously published and now united under one cover, with indexes of host plants and of parasitic or saprophytic fungi. The plants were studied in the dry condition or from specimens preserved in lactophenol. Three mycetozoa hold the first place, then follow a few of the larger fungi. The remaining, about 140 in all, are microscopic species, many of them troublesome parasites. The drawings represent microscopic characters.

A. L. S.

Fungi of the Dominican Republic.—ROMUALDO GONZALEZ FRAGOSO and RAFAEL CIFERRI ("Hongos parasitos y saprofitos de la republica dominicana," *Estación Agronom. Haina, Ser. B. and D., Bot., Santo Domingo, R.D.*, 1926, nos. 4, 5, 7, 1-10, 1-13, 1-14). In these papers the authors give further contributions to a complete mycological flora of Dominica. The species are listed with locality and habitat, and are mostly micromycetes. A number of species are new to science. Two new genera, *Jainesia* (Hyphomycetes) and *Fragosoa* (Hysteriaceæ), have been described.

A. L. S.

Fungus Drawings from the Dominican Republic.—ROMUALDO GONZALEZ FRAGOSA and RAFAEL CIFERRI ("Iconografia de hongos parasitos y saprofitos de la republica dominicana," *Estación Agronom. de Moca, Ser. B., Bot., Santo Domingo, R.D.*, 1926, 1-5, 11 pls.). The plates illustrate the microscopic characters of the new species of micro-fungi described elsewhere by the authors.

A. L. S.

Fungi of the Soil.—WILLIAM B. BRIERLEY ("The Micro-flora of the Soil (1) the Soil Bacteria, (2) the Soil Fungi," *Journ. Quat. Microsc. Club*, 1923, 16, 11-18, 1 pl.). A short account is given of the occurrence of bacteria in the soil, as, for instance, *Bacillus subtilis*, *B. caudatus*, etc. Immense numbers are still undetermined. Bacteria aid in the decomposing of organic remains and provide nitrates. Some of them cause serious plant diseases. As regards soil fungi, they also occur in enormous numbers, both of genera, species and individuals. Different soils vary in their numerical fungal content. The fungi are most numerous in the upper soil layers; they are practically non-existent below about three feet. They play an important part in decomposing the cellulose of plant residues, utilising the material to form their protoplasm, which in turn becomes an important part of soil organic matter. As in bacteria, many of them are harmful organisms and attack the higher plants.

A. L. S.

Pathological Fungi.—ALDO CASTELLANI ("Notes on Blastomycosis: its Aetiology and Clinical Varieties," *Proc. Roy. Soc. Medicine*, 1923, 21, 1-15, 10 text-figs.). The term "blastomycosis cutis, sensu lato," is given to skin diseases due to the so-called yeast-like fungi, or "budding fungi." Castellani has given a series of descriptions of these fungi that cause skin disease. He classifies them under three genera—*Blastomyces*, *Cryptococcus*, and *Momilia*. A number of cases of Blastomycosis are cited—the appearance of the diseased parts, the nature of

the fungus, and the treatment. Most of the cases reported occurred in warm countries. Four have been observed in England, but three of these had contracted the affection abroad.

A. L. S.

Physalospora Disease of the Basket Willow.—R. M. NATTRASS (*Trans. Brit. Mycol. Soc.*, 1928, 13, 286–304, 4 pls.). Nattrass has investigated this disease from material received from Somerset willow-growing districts. It causes a blackening of the leaves, die-back of the young shoots, and the formation of lesions or cankers on the rods. The presence of the fungus has been long known, but it was generally considered to be a wound parasite. *Fusicladium saliciperdu* is frequently associated with it. By means of cultures and inoculations Nattrass has demonstrated the parasitic nature of the fungus: it directly infects the leaves and growing tips and afterwards grows downwards into the stem. It overwinters by means of perithecia on the old lesions on twigs lying on the ground. Provisionally it has been referred to *Physalospora Miyabeana*, which it resembles in many particulars.

A. L. S.

Disease of Water Plants.—W. S. BOURN and BERENICE JENKINS ("Rhizoctonia Disease on Certain Aquatic Plants," *Bot. Gaz.*, 1928, 85, 413–26, 4 pls., 6 text-figs.). The authors have been concerned with plants such as *Potamogeton*, *Ruppia* and *Vallisneria*, which grow in the inland waters of North Carolina, representing one of the most important winter feeding-grounds for migratory wildfowl in the United States. Vast areas have been denuded of their aquatic vegetation owing to a fungus disease. After investigation, the disease was identified with *Rhizoctonia Solani*, the common host of which is the potato, though 105 species of plants have been reported as subject to attack of the fungus. It is supposed that infection was conveyed from diseased potatoes. The characters of the fungus—mycelium, sclerotia, etc.—are described. Inoculations in greenhouse aquaria, etc., were successfully carried out, and proved beyond question the nature of the disease.

A. L. S.

Diseases of Sugar-Cane.—JAMES A. FARIS ("Three Helminthosporium Diseases of Sugar-Cane," *Phytopathology*, 1928, 18, 753–74, 1 col. pl., 5 text-figs.). The immediate reason for this study was the occurrence of an eye-spot disease of sugar-cane in Cuba. The author has studied the accounts of other similar diseases caused by *Helminthosporium Sacchari* and *H. stenospilum*, and has decided that he is dealing with a new disease due to *H. ocellum* n. sp., the cause of the eye-spot disease. *H. stenospilum* is the fungus of brown stripe disease, *H. Sacchari* is the origin of Helminthosporiose. Brown stripe and eye-spot Helminthosporiums are widely distributed in Cuba. The latter is destructive of only a few varieties of cane. Brown stripe is a more serious disease, especially in dry weather. The microscopic and culture characters of the three fungi are described, and their effect on the growing canes.

A. L. S.

Blossom-Wilt of Apple Trees.—C. BOYLE, M. MURPHY, and H. A. CUMMINS ("Blossom-Wilt of Apple Trees and 'Wither-Tip' of Plum Trees, with Special Reference to Two Biologic Forms of *Monilia cinerea*," *Sci. Proc. Roy. Soc. Dublin*, 1928, 19, 63–76, 3 pls.). The aim of the research was to discover whether there were two distinct forms of *Monilia cinerea* in Ireland, causing blossom-wilt of apple trees and wither-tip of plum trees. Cultural and inoculation experiments were made. The results proved that there were two forms. Flowers of plum inoculated with the fungus from the plum were killed—flowers, pedicels and branches. When inoculated with blossom-wilt from apple trees, the flowers alone

died, the pedicels remained green and healthy. Differences in cultures were also found, and are described, and justify the establishment of forma *Mali* and forma *Pruni*.

A. L. S.

Mycological Notes (14).—W. SMALL ("Further Notes on *Rhizoctonia bataticola*," *Trop. Agriculturist, Ceylon*, 1928, 71, 77-80). The writer gives an account of several instances of attack by *Rhizoctonia*. It is recorded on roots of tea in Sumatra. *Citrus* seedlings were destroyed at Peradeniya, and several other instances are given. Wilted sunflower plants (*Helianthus annuus*) showed large numbers of sclerotia in the cortex of the stems at ground level. Pycnidia (*Macrophoma phaseoli* stage) occurred among the masses of sclerotia on the sunflower stems. The spores were grown in culture and reproduced again the sclerotia of *Rhizoctonia*.

A. L. S.

Powdery Mildew of Raspberry.—P. D. PETERSON and H. W. JOHNSON (*Phytopathology*, 1928, 18, 787-96, 2 text-figs.). Since 1923 powdery mildew (probably *Sphaerotheca Humuli*) has become abundant in various States of N. America. The writers give records of its occurrence and describe the symptoms—dwarfing of the leaves, stunting of the terminal growth, etc. The perithecia of the fungus were not found on the leaves in the States, but the conidial stage is invariably attacked by the parasite *Cicinnobolus cesati*, and that may hinder the further development. The fungus can persist throughout the winter in infected raspberry buds, and thus carries over the disease to the new season: conidia are short-lived. As a cure, clean-digging is suggested. The custom is to dig all of the canes in the row each autumn and to allow the underground parts to come up the following spring.

A. L. S.

Parasitic Fungi in Central France.—EUG. MAYOR ("Herborisations mycologiques dans les Monts de Lacagne (Tarn)," *Bull. Soc. Mycol. France*, 1928, 44, 79-93). The region examined was the hilly country forming a prolongation of the Cevennes, a region of rounded hills and valleys. There are practically no forests. The author devoted himself to certain groups, Peronosporæ, Exoascæ, Erysiphææ, Ustilaginæ, and Uredinæ; 138 species in all were collected, the larger proportion being different species and varieties of Uredinæ. One new species, *Uredo ulicis*, is described; it was infested by the parasite *Darlucia filum*. An examination of the country round Albi and Carcassonne yielded also a number of parasitic fungi, mostly Uredinæ.

A. L. S.

Ustilina zonata in the Tropics.—F. W. SOUTH (*Trop. Agriculturist, Ceylon*, 1928, 71, 97). The author describes the fungus *Ustilina zonata* as it infests the older rubber estates, usually attacking the main stems and branches of the rubber trees. He insists on the necessity of destroying all loose branches, etc., as sources of infection. The wind carries the spores to other growing branches and penetrates by wounds. Much damage is caused.

A. L. S.

Fungus Disease of Liriodendron.—CHARLES KILLIAN and ROGER GUY WERNER ("L'*Ectostroma liriodendri* Fr. des auteurs, maladie pseudo-cryptogamique du *Liriodendron tulipifera* L.," *Bull. Soc. Mycol. France*, 1928, 44, 63-8, 2 pls.). By means of cultures and of microscopic examination of material the authors have established the facultative parasitism of this fungus; the conidial stage, *Stigmium liriodendri*, develops in leaves (probably a wound parasite). Pycnidia are formed on sub-epidermal sclerotia, and have been described as *Phyllosticta tulipifera*. The fungus is now recognised as a species of *Ectostroma*.

A. L. S.

Disease of the Snowberry.—M. F. BARRUS and JAMES G. HORSFALL ("Preliminary Note on Snowberry Anthracnose," *Phytopathology*, 1928, 18, 797–801, 2 pls.). The snowberry, *Symphoricarpos albus*, was found to be attacked by a fungus causing anthracnose, which disfigured and killed both leaves and fruit, thus destroying the ornamental value of the shrub. The disease was traced to *Sphaceloma symphoricarpi* n. sp., which forms subcuticular acervuli—a stroma with conidia apical on upright conidiophores, at first hyaline, then dark.

A. L. S.

Lichens.

A New Species of Toninia.—MAURICE CHOISY ("A propos d' une nouvelle espèce de Lichen, *Toninia* (s.-g. *Thalladema*) *alluvicola* Choisy," *Bull. Soc. Bot. France*, 1928, sér. 5, 4, 80–2). The species had been confused with *Toninia cœruleo-nigricans*. After recounting the several variations in character between the two lichens, Choisy indicates differences in habitat and association. The new species is more generally muscicolous, and grows in association with *Psora decipiens*, *Lecanora fulgens*, etc., whereas *Toninia cœruleo-nigricans* grows in the soil interstices of rocks in company with *Dermatocarpon rufescens* and in close proximity to *Acarospora glaucocarpa*.

A. L. S.

Parasymbiosis of Celidium stictarum.—ROGER GUY WERNER ("Etude biologique et physiologique du *Celidium stictarum* (De Not.) Tul.," *Bull. Soc. Mycol. France*, 1928, 44, 194–205, 2 pls.). The author published recently a study of *Abrothallus parmeliarum*, and proved the non-parasitism of that lichen species. *Celidium stictarum* is a well-known inhabitant of the thallus of various frondose lichens (*Lobaria pulmonacea*, etc.). He has proved that on infection the hyphæ of the *Celidium* unite with the gonidia of the host thallus, but do not injure these; it is a symbiotic relationship characterised as parasymbiosis. The development of the intruding organism has been followed throughout. It associates closely with the gonidia, but does not penetrate them; it is, therefore, non-parasitic. It also enters into combination with the Nostocs that form internal cephalodia in *Sticta*, a condition described by Werner as pseudo-parasymbiosis.

A. L. S.

Podetium of Cladonia.—M. et MME. FERNAND MOREAU ("A propos de la signification du podétion des *Cladonia*. Réponse à M. Choisy," *Bull. Soc. Mycol. France*, 1928, 44, 206–7). It is a debated question whether the podetium of the *Cladonia* may have developed originally as a fruit stalk. The Moreaus take the view that it is an outgrowth from the thallus somewhat similar to isidial outgrowths. They here restate their case, which was challenged by Choisy.

A. L. S.

Arctic Lichens.—ROBERT PAULSON ("Lichens of Spitzbergen and North-East Land," *Journ. Bot.*, 1928, 66, 249–53). The lichens here enumerated were collected by C. S. Elton on the Oxford University Arctic Expedition. Paulson examined these and also some geological specimens on which lichens were growing. Various notes were made on the influence of arctic conditions on some familiar lichens: *Lecidea Dicksonii*, for instance, tended to lose, not only the characteristic red colour, but the thallus itself dwindled and disappeared, only the hypothallus and apothecia remaining. Several lichens new to Spitzbergen are recorded. The list includes 119 species and 4 varieties.

A. L. S.

Buellia of Brazil.—GUST. O. A. N. MALME ("Buellia itineris Regnelliani primi," *Ark. Bot.*, 1928, 21, N. 14, 1–42). Malme comments on the large number of *Buellia* species and individuals that he found growing in South Brazil. One

species, *Buellia modesta*, was one of the most frequent of lichens on the bark of trees. A comparative account is given of the occurrence of the various *Buellia* in Matto Grosso, Paraguay, Rio Grande do Sul, and some other localities. Malme concludes that there must be a considerable number of endemic lichen species in the region, which is geologically old, and that, as with phanerogams, there is probably a great difference between the Eastern and Western flora. Notes are given on the division of the genus into three sections. Better results would be arrived at by a study of the spore alone, as the sections overlap. A useful artificial key is provided of the species, 47 in number. Many of these are new to science, and are described at length. One of them, *Buellia termitophila*, was found in four localities, always on ant-hills.

A. L. S.

Lichens of Polesine.—A. VILLANI ("Licheni ritrovati nel Polesine dal Cav. G. Grigolato, Rodigno," *Nuovo Giorn. Bot. Ital.*, 1927, 34, 503-7). Villani found a small collection of lichens preserved in the Academia dei Concor di Rovigo. Villani has now published these lichens, 24 in all, as determined, and with the notes of Grigolato as to locality and habitat.

A. L. S.

Lichens of Rhodes Island.—M. CENGIA SAMBO ("Licheni de Rodi, II," *Nuovo Giorn. Bot. Ital.*, 1927, 34, 829-31). Notes are given by the author on a collection of 41 lichens made by Sig. Senni. He refers to the air currents that carry the spores, and argues that Rhodes lies in the current that sweeps round the north of Africa and the Eastern Mediterranean, so that one would expect the lichens to be similar to those of Greece, Cyprus and Crete, Southern Dalmatia and Southern Italy. Cengia Sambo found that the lichen flora was similar to that of the Eastern Mediterranean.

A. L. S.

Epiphytal Lichens.—W. G. PAKHUNOWA ("A Note Concerning the Epiphytal Lichens of Suhun and its Outskirts," *Moniteur Jard. Bot. Tiflis*, 1926-27, 57-60, Russian with English summary). The author, in her account of lichens on the leaves of trees, includes species that grow as well on bark, etc., such as *Parmelia physodes*. Those obligate on leaves are *Biatorina bouteillei* and *Pilocarpon leucoblepharum*.

A. L. S.

Lichens from the Mil-Steppe (Azerbaijan) (*op. cit.* 203-7). Another paper by the same author, which deals with soil lichens collected by A. A. Grossheim in October, 1926. She points out three lichens not yet mentioned in Caucasian lichenological literature—*Squamaria muralis*, f. *albomarginata*, *Collema granulatum*, and *C. cristatum*. The two latter lichens have been found on soil in Britain. Her work was done at the Tiflis Botanical Garden.

A. L. S.

Lichens of Nova Zembla.—BERNT LYNGE ("Lichens from Novaya Zemlya (excl. of Acarospora and Lecanora)," *Det Norske Vidensk.-Abt. Oslo*, 1928, 1-298, 13 pls. and map). Lyngé divides the territory into six localities from (I) the Southern Fjords to (VI) Farthest North, but practically all the lichens were collected in the lowlands and on the talus slopes. About 7,000 specimens of lichens were secured. A full account of the different localities has been given, especially of the exposure. The climate he finds more favourable for lichen growth than for vascular plants. Soredia in the Arctic are not of much value; the plant is propagated mainly by portions of the thallus. Lyngé has enumerated 413 lichens; and calculates that many microscopic plants were unavoidably overlooked. The effect of the ice age is fully discussed. "Novaya Zemlya has been profoundly immersed in the sea during a post-glacial period," and therefore the flora may be

considered recent. The work is enriched throughout with biological notes on the different species. Lists of writings on Arctic lichens and a copious index are provided. A. L. S.

British Lichenology.—H. H. KNIGHT ("Lichens of the Marlborough Foray and Lichens of Aviemore District," *Trans. Brit. Mycol. Soc.*, 1928, 13, 149–50, 314–16). The first contribution concerning Marlborough lichens deals mainly with arboreal species from the various wooded localities; only a few saxicolous species were found on walls. It was noted that the old trees were the most prolific in lichens. The rarity of the larger forms was commented on; it is due to the cutting down of the old trees. A considerable number of varied species were listed. At Aviemore conditions were very different; there was an abundance of rock specimens and also many of the northern and Alpine forms, such as *Gyrophoreæ* and *Cetrariæ*. No species of the family Graphidaceæ was found. Species generally sterile, such as *Parmelia physodes*, were found with apothecia. The list amounts to 160 species, varieties and forms. A. L. S.

Lichens of Monte Ferrato.—E. SAMBO ("I Licheni del Monte Ferrato (Toscana)," *Nuovo Giorn. Bot. Ital.*, 1927, 34, 333–8). The author gives a sketch of Italian lichenology, which originated in 1729 with Micheli's great work on plants. In the following list of 100 species or varieties Sambo records 46 new to Tuscany, nine being new to Italy and three new to science. To these are added 23 of the 35 species collected also on Monte Ferrato by Beccari and Marcucci, and determined by Baglietto. The region is composed of serpentine and granite, and the mountain is covered with pine trees. Sambo has found that lichens considered calcicolous are present on siliceous (magnesian) rocks. He discusses the occurrence and distribution of the lichen flora. A species known only from Brazil, *Phylliscidium monophyllum*, grew there, but as it is almost microscopic in size, it may have been overlooked in other and nearer localities. A. L. S.

Mycetozoa.

Mycetozoa of Santo Domingo.—RAFAEL A. TORO ("Mixomicetos de Santo Domingo," *Estación Agronom. Haina, Ser. D., Bot., Santo Domingo, R.D.*, 1926, 1–7, 2 text-figs.). The few mycetozoa herein described were collected by F. D. Kern and R. A. Toro. It is a first contribution to the knowledge of the island mycetozoa. The habitat in all cases was the trunks of palm trees. A. L. S.

Mycetozoa of Sumatra.—K. B. BOEDIJN ("Verzeichnis der von Sumatra bekannten Mycetozoa," *Ann. Mycol.*, 1928, 26, 450–3). According to the author, very little has been known about the mycetozoa of Sumatra. He has now made a collection mainly from the east coast, near Medan (Deli). He lists 43 species, giving habitat—very generally dead wood. Boedijn describes a new species, *Ceratiomyxa sphærosperma*. A. L. S.

Mycetozoa of the Aviemore Foray.—G. LISTER (*Trans. Brit. Mycol. Soc.*, 1928, 13, 312–13). The hunting-grounds around Aviemore consisted chiefly of native woods of Scots pine with undergrowths of heather, bilberry, etc., old stumps of trees and heaps of sawdust. The weather had been wet the previous week, and many forms seen were in the plasmodium stage or entirely weather-beaten. The list is therefore shorter than might have been expected from the locality. One species, *Oligonema nitens*, new to Scotland, was found. A. L. S.

Plasmodiophorales.

Notes on the genus *Ligniera*.—W. R. IVIMEY COOK ("Quelques observations sur le genre *Ligniera*," *Bull. Soc. Mycol. France*, 1928, 44, 105-8). Cook, in this paper, takes occasion to review the species of *Ligniera* found in France, and to criticise the literature of *Ligniera Junci*, to which belong most of the species described; Cook has proved this by examination and comparison of specimens and by culture tests. In this species is also to be included *Anisomyxa Plantaginis*. A description is given of the peculiar characters of nuclear division in the Plasmodiophorales already published in the *Annals of Botany*. A. L. S.

TECHNICAL MICROSCOPY.

Use of Endell Heating Microscope for Examination of Solid Fuels.—E. BERL and H. SCHILDWACHTER (*Brennstoff Chem.*, 1928, 9, 159). A description is given of a microscope fitted with an electrically heated stage by which the heating of fuels in any desired atmosphere can be studied. A. H.

Chemical Microscopy. I. Crystallisation Experiments as Introduction to Metallography.—E. M. CHAMOT and C. W. MASON (*J. Chem. Education*, 1928, 5, 9-24). As a preliminary to the microscopical study of surfaced and etched metals and alloys, the authors have devised a series of experiments with compounds which crystallise well from their melts. These enable a student to follow solidification as it takes place, which is not possible with metals or alloys. The substance or mixture is fused between two cover-glasses and cooled on a brass block having a hole 1 cm. square. This enables heat to be abstracted from the edges first, so that crystal growth proceeds inwards. Repeated melting and freezing can be carried out on a hot stage. Blow-holes in metals can be imitated by using substances which give off dissolved gases while cooling. A list of substances which have been found suitable for this study is given, and the paper is illustrated with 22 figures. A. H.

Crystallisation of Paraffin Wax.—F. H. RHODES, C. W. MASON, and W. R. SUTTON (*Industrial and Engineering Chemistry*, 1927, 19, 935). Slack wax was fractionally crystallised, the melting-points and average molecular weights of the fractions being determined. Each fraction was then examined microscopically while crystallising from its own melt, the rates of cooling being regulated by a hot stage controlled to 0.1° C. All fractions behaved in the same way, although naturally the temperatures at which the changes took place were different. Small plates are first formed, which in the case of rapid cooling become polygonal in shape, due to the rolling up of the edges of the plates. Needle crystals then develop tangential to the original plate. Very slow crystallisation results in the formation of plates only. The two forms of crystals are of the same composition. The needle-like crystals are shown to be rolled-up plates. A. H.

Cause and Removal of Certain Heterogeneities in Glass.—L. W. TILTON, A. N. FINN, and A. Q. TOOL (*U.S. Bureau of Standards, Scientific Paper No. 572*, 719-36). The results of an investigation into the causes of the hetero-

geneities in six barium flint lens from the same melt has led the authors to draw the following conclusions:—Under conditions conforming to present good practice in production, differences in heat history cause optical density variations in practically strain-free glass which render its use questionable for the most exacting requirements. Such variations are largely removable by re-annealing after a pre-heating, provided the furnace temperature gradients are sufficiently low. In properly selected glass the maximum effects due solely to differences in chemical composition, if any exist, are small at the sixth decimal place of index of refraction.

A. H.

Photomicrography of Textile Materials with Dark-Ground Illumination.—A. KLUGHARDT (*Faserforschung*, 1928, 6, 129–32, through *Chemical Abstracts*, 1928, 22, 3049). A series of photomicrographs obtained with the aid of a Hauser condenser (Emil Busch, Rathenhow) show a wealth of detail.

A. H.

Microscopical Examination of Metallic Minerals.—J. ORCEL (*Bull. Soc. d'Encour.*, 1928, 127, 503–27). A description of the technique of the preparation, etching, and microscopical examination of sections of minerals.

A. H.

“Binomax” Greenough Binocular Microscope.—For low-power microscopy the Greenough binocular microscope has particular advantages, and all workers who can afford it usually possess and regularly use one. Messrs. R. and J. Beck have recently produced a model called the Binomax, which has advantages over the orthodox type and which tends to reduce the price, a point of considerable importance at a time when the cost of apparatus is still high. The chief characteristic of the new instrument is that each pair of objectives provides two magnifications; thus with one pair of objectives and two pairs of oculars magnifications of 4, 8, 16 and 32 can be obtained.

The Binomax consists of two complete microscope systems inclined to each other at the natural convergence of the eyes. Each system has a prismatic erecting arrangement. The interocular distance is adjusted by revolving the prism boxes. The method of obtaining the four powers with only one pair of object glasses is a new one. The object glasses are held in tubular mounts with the lenses at one end. Each object glass is so threaded that it can be placed in the microscope body in two ways, one way having the tubular mount projecting out of the body and the other with the tubular mount inside the body. By this means the distance between object glass and eyepiece is made to differ very considerably, and widely different powers are therefore obtained. The optical performance is not interfered with, as the object glass by this process is reversed. The accompanying diagram illustrates the principle upon which the Binomax is made. The object glass (a) is shown screwed on to the body with its lenses projecting in front of the microscope. In dotted lines the position (a') is shown into which it can be screwed in the interior of the body. The image is formed by this object glass at a position (b) and is examined by the eyepiece. The point (o) is the position of the object. The distance between the object (o) and the position (a) and the distance between (o) and the position (a') are so arranged that (oa) is equal to (a'b) and (oa') is equal to (ab). The image is therefore in focus at (b) whichever way the object glass is screwed on to the body, but different powers are obtained. If the object glass is corrected to work in the position (a), it will also work in the position (a'), and provided that the lenses are reversed, which is done by reversing the whole mount, the optical corrections are in each case equally perfect. In a binocular instrument the object

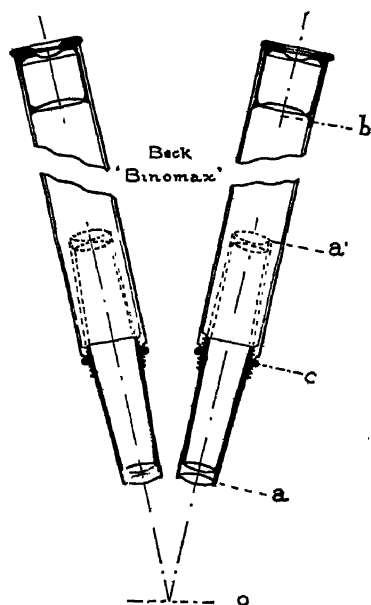


FIG. 1.

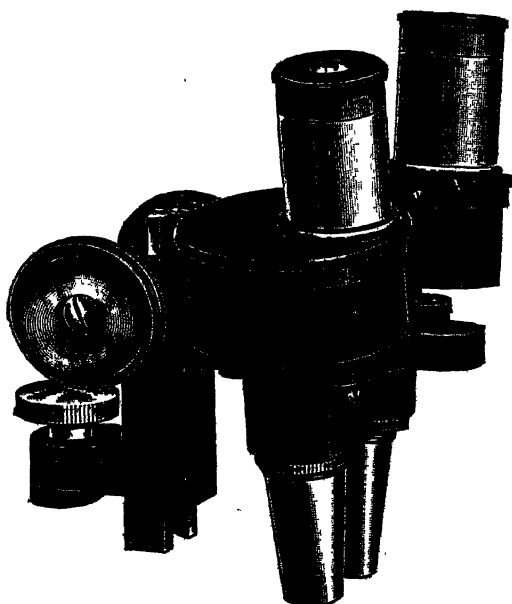


FIG. 2.

must lie at the intersection of the two optic axes of the microscopes, and the change in power is therefore made without altering the distance between the object and the bodies of the microscope. The following table gives the working distances and the field of view of the Binomax :—

Magnifying Powers.	Working Distance.	Diameter of Field of View.
×4	110 mm.	88 mm.
×8	110 mm.	22 mm.
×16	75 mm.	9 mm.
×32	75 mm.	5 mm.

In conjunction with the Binomax various types of stand are provided adapted for using the magnifier for any suitable purpose.

The Binomax is made with and without rack-and-pinion adjustment, and is provided with a lug and clamping screw, by means of which the instrument itself is interchangeable on the various stands should more than one be desired.

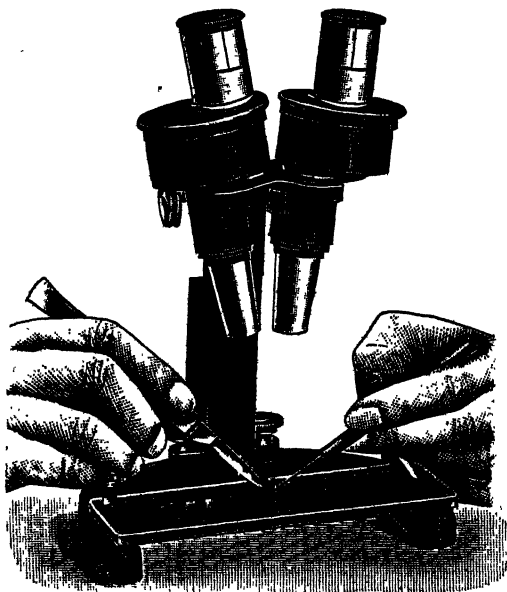


FIG. 3.

An attachment is made for illuminating objects under examination. It consists of a small 12-volt lamp, which can be run off an accumulator or from the mains with a suitable resistance, together with a condensing lens to throw a brilliant light upon the object. The attachment is fixed to the Binomax moving with it as the rack and pinion is actuated.

F. V. W.

NOTICES OF NEW BOOKS.

The Spectroscopy of the Extreme Ultra-Violet.—By THEODORE LYMAN, Ph.D. 1928. 2nd Edition. vii, 160 pp., 1 plate, 7 text-figs. Published by Longmans, Green & Co., Ltd., 39, Paternoster Row, London, E.C. 4. Price 10s. 6d.

Faune de France.—Vol. XVIII. Diptères (Nématocères)—Chironomidæ. III. Chironomariæ.—By M. GOETGHEBUER. 1928. 174 pp., 275 text-figs. 32 francs. Vol. XIX. Hyménoptères vespiformes. II. (Eumendiæ, Vespidae, Masaridæ, Bethyridæ, Dryinidæ, Embolemidæ).—By L. BERLAND. 1928. viii, 208 pp., 232 text-figs. Published by Paul Lechevalier, 12, Rue de Tournon, Paris. Price 36 francs.

Further Correspondence of John Ray.—By R. W. T. GUNTHER. 1928. xxiv, 332 pp., 5 plates, 6 text-figs. Published by the Ray Society, London.

The National Physical Laboratory.—Collected Researches. Vol. XX. 1927. 444 pp., 13 plates, numerous text-figs. Published by H.M. Stationery Office, Adastral House, Kingsway, London, W.C. 2. Price 18s. 6d.

Microscope Record.—No. 15. September, 1928. 31 pp. Published gratis by W. Watson & Sons, Ltd., 313, High Holborn, London, W.C. 1.

Illustrated Catalogue of Microscopes and Accessories.—33rd Edition. 1928. 160 pp., numerous plates and text-figs. Published gratis by W. Watson & Sons, Ltd., 313, High Holborn, London, W.C. 1.

Lehrbuch der Blutkrankheiten (Text-Book of Diseases of the Blood).—By H. HIRSCHFELD. 2nd Edition, 263 pp., 43 text-figures, 5 coloured plates. Published by Johann Ambrosius Barth, Leipzig, 1928.

Although this book is mainly intended for medical practitioners and students, it contains much purely microscopical information relating to the normal blood and blood-forming tissues.

The first chapter deals fairly exhaustively with the normal variations of the morphological constituents of the blood, and also contains an excellent account of the various methods of examining and staining blood-cells. The description of blood formation and destruction, although confined to the human being, is most illuminatingly written, although, as it forms part of a students' text-book, there is nothing revolutionary in it.

The rest of the book contains detailed accounts of pathological changes in the blood, with much emphasis on the microscopical aspect of the subject.

The text-figures, which illustrate both macroscopic and microscopic characters of the blood-forming tissues, are well done, and the five coloured plates at the end of the book are really beautiful. The first illustrates all the important normal cells of blood and blood-forming tissue; the second shows single microscope fields

of blood-films; the third is similar, also the fourth; the fifth shows the detailed characters of various protozoal parasites in the blood.

The book is most satisfactory except for the price, which is unduly high (marks 22 for an unbound copy). A. P.

Das Mikroskop.—By PAUL METZNER. 1928. xi, 509 pp., 372 text-figs. Published by Franz Deuticke, Wien and Leipzig. Price M. 38-60.

This work is a comprehensive survey of the microscope and microscopical optics. The subject is dealt with on conventional but comprehensive lines. Opening with a chapter on general optics, together with the theory of the formation of the microscopic image, it continues with an account of the microscope and its accompanying appliances. Objectives, oculars, micrometric methods, light sources of many recognised types, are described. Testing of the optical and mechanical parts is considered, although one fails to find any reference to the interferometric methods that have been developed in this country. Micro-dissection and micro-chemical methods are referred to in some detail, and the book concludes with a chapter on micro-projection. At the end of each chapter are some references to current literature, but they cannot be described as exhaustive. J. E. B.

Das Polarisationsmikroskop.—By HERMANN AMBRONN and ALBERT FREY. 1926. x, 194 pp., 1 plate, 48 text-figs. Published by Akademische Verlagsgesellschaft m.b.H., Leipzig.

This work deals adequately with its subject from both its theoretical and practical aspects. It commences with a general account of polarisation and with a description of the various special appliances used in the polarising microscope. The illustrations and description of the optical path of rays passing through such a microscope are of interest to many, even if they are not specialists in this branch of microscopy. The greater part of the book deals with some of the varied applications to chemistry, crystallography, and other branches of science, and fittingly concludes a work that may be commended to students of the subject. J. E. B.

Atomic Structure as Modified by Oxidation and Reduction.—By WILLIAM COLEBROOK REYNOLDS. 1928. vi, 128 pp., 11 text-figs. Published by Longmans, Green & Co., Ltd., 39, Paternoster Row, London, E.C. 4. Price 7s. 6d.

Of the numerous atomic structures that have from time to time been advanced since the discovery of the essential constituents of the chemical atom, namely, the existence of a central positively charged nucleus with extranuclear negatively charged electrons, which in the neutral atom are numerically equivalent to the number of units of positive charge on the nucleus, the two most important are undoubtedly the Lewis-Langmuir atom and the Böhr atom. In the former—"the chemist's atom"—the electrons occupied static positions relative to the nucleus about which they formed "shells," and this view enabled chemical combination to be depicted in terms of electronic exchange and sharing. The Böhr atom, on the other hand, was particularly acceptable to the physicists, who, by picturing the electron as describing planetary motion in orbits around the nucleus, were enabled to interpret the line spectra of elements like hydrogen, helium, etc. In the present treatment the atom is pictured with its central positive nucleus outside of which the electrons are orientated, describing spiral motion in rotating about centres symmetrically placed with regard to the nucleus. On this conception the author shows how the characteristic properties of the chemical elements may

be readily interpreted and the structures of the rare earths and the transition elements are easily explained. The electrons are classed in three groups: (a) valence electrons—these are situated farthest from the nucleus and are mainly responsible for the chemical activity of the atom; (b) potential valence electrons—these are not directly involved in chemical reactions, but may, as the result of oxidation and reduction processes, be rendered “available” for chemical activity; (c) the radial pairs and quartets are relatively stable electron placements next the nucleus.

The author proposes “activation” and “deactivation” for oxidation and reduction, since the latter in the broadest sense are dependent upon the extent to which the atomic structure is modified—activated—by the mobilising of the potential valence electrons for chemical activity.

Physical phenomena, too, are capable of interpretation. The electrons in uniform spiral motion in circular orbits give rise to magnetic fields and constitute magnetic shells—radiation is neither absorbed nor emitted. However, when subjected to displacements from their normal orbits, the reactionary forces of recovery cause the electrons to describe periodic oscillatory motion about their orbits before settling down to smooth spiral motion again. Emission and absorption of radiation are associated with such displacements and consequent periodic motion. Interpretations of such radiation phenomena as line and band spectra, X-ray emission and ionization, are also indicated.

In the concluding portion Dr. Reynolds puts forward the novel conception that the ether is a non-homogeneous fluid permeating everywhere and everything with the exception of protons and electrons. It contains at least two constituents—corpuscles of positive and negative electricity of masses extremely small compared with that of electron. “Apparent electricity” and gravitation are the result of absorption of electricity—preferential absorption of ether constituents; proton absorbs negative and reflects positive corpuscles, and the electron *vice versa*. Magnetic forces are ether currents set up by the spinning motion of electrons and protons.

Refraction, dispersion, and dielectric properties of media are functions of the super-position of motion of cross-currents of ether produced by atomic magnetic shells on the ethereal wave motion being propagated through the medium.

The book, which is obviously not intended as a treatise, presents in outline a view of atomic structure which is full of possibilities and may well prove exceedingly fruitful in the future in the need for a “universal atom” which meets the requirements of both chemists and spectroscopists alike.

This book is of interest to microscopists because of the new suggestions thrown out in reference to radiation phenomena, particularly to refraction and dispersion, which are of fundamental importance in optical instruments.

J. E. B.

PROCEEDINGS OF THE SOCIETY.

AN ORDINARY MEETING

OF THE SOCIETY WAS HELD AT 20 HANOVER SQUARE, W.1, ON WEDNESDAY, OCTOBER 17TH, 1928, MR. JOSEPH E. BARNARD, F.R.S., PRESIDENT, IN THE CHAIR.

The Minutes of the preceding Meeting were read, confirmed, and signed by the President.

The nomination certificates in favour of the following candidates were read for the first time :—

Charles Robert Becke, Yarmouth, I.O.W.
 D. M. Blair, King's College, Strand.
 Ernest Goddefroy, Brussels.
 Edward Francis Goode, Melbourne.
 Alfred Ernest Harris, Cardiff.
 William McCully James, Ancon.
 A. Francis Law, Sarawak.
 Arthur Duncan McClay, Earl's Court.
 Doris L. Mackinnon, King's College, Strand.
 Robert Conacher Malcolm, Calcutta.
 Vishwa Nath, Lahore.
 Josslyn Vere Ramsden, Ford, Salop.

Donations received during the Vacation were reported from :

Messrs. Chapman & Hall—

“ The Microscopy of Drinking Water ” (Whipple).

Trustees of the British Museum—

Catalogue of the Library of the British Museum (Natural History).
 6 vols.

“ Index Animalium ” (Sherborn). Parts XIII and XIV.

National Physical Laboratory—

Collected Researches. Vol. XX.

M. Paul Lechevalier—

“ Faune de France. Part XVIII. Diptères (Nématocères) ”
 (Goetghebuer).

MM. Masson & Cie.—

“*Traité de Zoologie. Part VIII. Développement Embryogénique des Vertébrés Allantoïdiens—Les Reptiles*” (Perrier).

“*Traité d'Embryologie comparée des Invertébrés*” (Dawydoff).

Cambridge University Press—

“*Bibliography of Sponges, 1551-1915*” (Vosmaer), edited by G. P. Bidder and C. S. Vosmaer-Röell.

Longmans, Green & Co.—

“*Atomic Structure*” (Reynolds).

Votes of thanks were accorded to the donors.

Exhibit.—Mr. Conrad Beck exhibited and described a new form of Greenough Binocular Microscope with invertible objectives.

A vote of thanks was accorded to Mr. Beck for his exhibit.

The following papers were read and discussed :

Professor E. Ghosh, M.Sc., M.D., F.Z.S., F.R.M.S. (*read by Dr. Tierney*)—

“Two New Ciliates from Sewer Water.”

Mr. J. E. Barnard, F.R.S., P.R.M.S., and Mr. F. V. Welch, F.R.M.S.—

“An Electrically-Heated Warm Stage with Compressor for Use with High-Power Objectives.”

Votes of thanks were accorded to the authors of the foregoing communications.

On the invitation of the President, Mr. Merfield, a visitor from Melbourne, then exhibited and described a series of lantern slides illustrating his work on diffraction gratings with Grayson's ruling machine.

The President, in expressing the thanks of the Meeting to Mr. Merfield for the interesting description of this important work, regretted that, owing to the lateness of the hour, it was not possible to discuss it, and ventured to hope that the Society might have the pleasure of receiving and discussing a further communication from Mr. Merfield in the near future.

The President announced that the Biological Section would meet in the Library on Wednesday, November 7th, at 7.30 p.m.

The business proceedings then terminated.

AN ORDINARY MEETING

OF THE SOCIETY WAS HELD AT 20 HANOVER SQUARE, W.1, ON WEDNESDAY, NOVEMBER 21ST, 1928, MR. JOSEPH E. BARNARD, F.R.S., PRESIDENT, IN THE CHAIR.

The Minutes of the preceding Meeting were read, confirmed, and signed by the President.

New Fellows.—The following candidates were balloted for and duly elected Ordinary Fellows of the Society :—

Charles Robert Becke.
Duncan M. Blair, M.B., Ch.B.
Ernest Goddefroy, M.B.E.
Edward Francis Goode.
Alfred Ernest Harris.
William McCully James, M.D.
A. Francis Law, M.B., B.Sc.
Arthur Duncan McClay.
Doris L. Mackinnon, D.Sc., F.L.S.
Robert Conacher Malcolm.
Vishwa Nath.
Lt.-Col. Josslyn Vere Ramsden, C.M.G., D.S.O., M.A.

THE Nomination Certificates of the following candidates were read for the first time :—

B. K. Johnson, Wembley.
A. R. Nizam, Seattle.
Takeo Tamiya, Tokyo.
Thomas William Watts, Norwich.

Donations were reported from :

Messrs. Longmans, Green & Co., Ltd.—

“The Spectroscopy of the Extreme Ultra-Violet.” 2nd Edition.
(Lyman.)

M. Paul Lechevalier—

“Faune de France. Vol. 19. Hyménoptères vespiformes. II.” (Berland.)

Mr. G. T. Harris—

An Old Portable Microscope in Case.

Votes of thanks were accorded to the donors.

Mr. W. E. Watson Baker described the microscope presented by Mr. G. T. Harris as being similar in every way to the dissecting microscope in the Society's collection, by Bate (c. 1780), but in addition it was provided with a spring object-holder, from which he thought it was intended for use also as a portable travelling microscope.

The President thanked Mr. Watson Baker for his description of this valuable addition to the Society's collection.

The Death was reported of :—

William G. De Witt. Elected 1885.

A vote of condolence with the relatives was passed.

The following papers were read and discussed :

Miss Kathleen M. Carter, M.Sc.—

“Ovule Development and Meiosis in *Orobanch minor*.”

Communicated by Professor Gates.

Dr. W. H. van Seters.—

“Tripod and Pillar Microscopes.”

Communicated by Dr. Tierney.

Votes of thanks were accorded to the authors of the foregoing communications.

The President announced that the Biological Section would meet in the Library on Wednesday, December 5th, 1928, at 7.30 p.m.

The proceedings then terminated.

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60, Bowes-road, Palmer's Green,
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*Walvens, Eastbury-road,
Ozhey, Herts.*
- 1922 Barnes, John Alfred, M.D., M.R.C.S., L.R.C.P.
Hawarden, Melton-road, Leicester.
- 1913 Barratt, Thomas Franklin.
12, *Hans-road, S.W. 3.*
- 1923 Barrett, Alfred.
The Chalet, Compton-road, Winchmore-hill.
- 1921 Batchelor, Arthur James.
Croftside, 3, Ivyday-grove, Streatham, S.W. 16.
- 1924 Batchelor, Henry Charles.
*c/o Messrs. Charles Hearson & Co., Ltd., 27, Mortimer-
street, W. 1.*
- 1920 Bates, George Frederick, B.A., B.Sc.
66, *Craigie-road, Perth.*
- 1918 Baxter, Charles Eldred, C.E.
7, *Parkinson's Chambers, Hustlergate, Bradford,
Yorks.*

Elected.

- 1899 Beale, Peyton Todd Bowman, F.R.C.S.
Lymore End, Everton, Lymington, Hants.
- 1885 *Beck, Conrad, C.B.E.
69, *Mortimer-street,*
London, W. 1.
- 1908 Bell, A. Dillon.
Shag Valley Station, Waihemo, Palmerston South,
Otago, New Zealand.
- 1910 Berridge, Miss Emily Mary, D.Sc., F.L.S.
7, *The Knoll, Beckenham, Kent.*
- 1918 Berry, John Leslie, M.B., Ch.B. .
151A, *New-street, Burton-on-Trent.*
- 1913 Bestow, Charles Horton.
Melford-house, 43, Upper Clapton-road, E. 5.
- 1919 Bhatia, Bihari Lal, M.Sc., F.Z.S.
Principal, Government College, Hoshiarpur, India.
- 1926 Bidder, George Parker, M.A., Sc.D., F.L.S.
Cavendish Corner, Cambridge.
- 1903 *Blood, Maurice, M.A., F.C.S.
10, *Park-avenue, Willesden Green, N.W. 2.*
- 1926 Blunderfield, Henry Charles.
Wigan Infirmary, Wigan.
- 1926 Bogue, Robert.
166A, *Duncan-street, San Francisco, Cal., U.S.A.*
- 1927 Borthwick, Sydney.
69, *Mortimer-street, W. 1.*
- 1926 Bottomley, Claud McClellan, B.Sc., F.C.S.
43, *Manor-road, Blackburn.*
- 1920 Bowell, Ernest W., M.A., M.R.C.S., L.R.C.P.
21, *Prince-road, South Norwood, S.E. 25.*
- 1921 Bowtell, Alexander James.
135, *Dalston-lane, E. 8.*
- 1923 Bowyer, Stephen Bernard, F.C.S., M.S.C.I.
20, *Beckenham-avenue, Epsom, Auckland, New Zealand.*
- 1910 Bracewell, Geoffrey Alfred.
Newlands, Toller-lane, Bradford, Yorkshire.
- 1921 Bradbury, J. G., F.R.P.S.
1, *Hogarth-hill, Finchley-road, Hendon, N.W. 11.*
- 1920 Bradford, Philip G., A.M.I.Mech.E.
c/o Messrs. Williams Deacon's Bank, Ltd., Rotherham,
Yorks.
- 1922 Bradley, Arthur Benjamin, F.C.S., M.S.C.I.
Fermain, Sutherland-grove, Southfields, S.W. 18.
- 1924 Brambell, F. W. Rogers, B.A., D.Sc., Ph.D.
Dept. of Zoology, King's College, Strand, W.C. 2.
- 1914 Brand, Felix.
103, *Biddulph Mansions, Elgin Avenue, Maida Vale, W.*

Service on
Council, etc.
1905

1904-1906 ; 1912-18 ;
1923-24 ;
V.-P. 1907-08

1919-20

1925-27

1927-

1927-

Elected.		Service on Council, etc.
1922	Bray, Reginald A., B.A. <i>Shere, Surrey.</i>	
1915	Brewster, Frank. <i>Hotel Continental, Chowringhee, Calcutta, India.</i>	
1905	Bridge, John William. <i>Brewer-street, Maidstone.</i>	
1925	Bright, Malcolm Addison. <i>c/o Bank of New Zealand, Christchurch, New Zealand.</i>	
1924	Bright, Thomas Binstead, B.A. <i>The Cove, Silverdale, Carnforth, Lancs.</i>	
1921	Brislee, Francis Joseph, D.Sc., F.I.C. <i>Wayside, Rupert-road, Huyton, near Liverpool.</i>	
1926	Brown, Frederick. <i>56, Booth-street, Cleckheaton, Yorks.</i>	
1887	Browne, Edward Thomas, F.Z.S. <i>Anglefield, Berkhamsted, Herts.</i>	1800-02
1923	Browning, Edgar W. F. <i>The Charterhouse, E.C. 1.</i>	
1911	Browning, Sidney Howard, L.R.C.P., M.R.C.S. <i>22, Harley-street, W. 1.</i>	1922-24
1926	Bruff, Albert. <i>High Street, Pershore, Worcs.</i>	
1925	Bryce, David L., F.R.S.E. <i>Salforde Parsonage, Horley, Surrey.</i>	
1923	Bucknill, Thomas, Barrister-at-law. <i>13, King's Bench-walk, Temple, E.C. 4.</i>	
1920	Bull, Henry H. <i>Trossley House, Trottiscliffe, W. Malling, Kent.</i>	
1920	Bullock-Webster, Rev. Canon George R., M.A., F.L.S. <i>1, All Hallows-lane, Upper Thames-street, E.C. 4.</i>	1925-28
1924	Bunning, George Belding. <i>63, Third-avenue, Queen's Park, W. 10.</i>	
1926	Burford, William Knibb. <i>The Manse, Tower-road, Hindhead, Surrey.</i>	
1920	Burgess, Arthur Savell, M.A., M.D., B.Ch. <i>Birch Hanger, Godalming, Surrey.</i>	
1913	Burns, Nesbitt, B.A., M.B., B.Ch. <i>The Lodge, Highbury, Somerset.</i>	
1922	Butler, Arthur Leslie. <i>Barton, Victoria-road, Sutton, Surrey.</i>	
1921	Caffyn, Charles Henry. <i>16, Bowes-road, Palmer's Green, N. 13.</i>	
1910	Caird, William John, J.P. <i>Schoolhouse, Sandhaven, Fraserburgh.</i>	
1920	Cannon, Herbert Graham, M.A., D.Sc., F.L.S., F.Z.S. <i>Professor of Zoology, The University, Sheffield.</i>	1923-25

Elected.

- 1913 Capell, Bruce J.
10, *Castelnau, Barnes, S.W.* 13.
- 1920 Carleton, H. M., B.A.
Physiology Laboratory, The University, Oxford.
- 1925 Carrel, F. Poingdestre.
c/o National Provincial Bank, 66, Charing Cross, S.W.
- 1910 Carter, John Arthur, M.I.M.E.
Uplees House, Uplees, Faversham, Kent.
- 1927 Castle, Thomas.
86, *Huddersfield Road, Liversedge, Yorks.*
- 1920 Cathcart, Eryk Hayman.
Manston House, Sidford, near Sidmouth, Devon.
- 1918 Cattley, Major Robert, M.B., C.M., B.Sc., etc.
43, *Main-avenue, Heworth, York.*
- 1928 Chanter, Alfred Samuel.
2, *Wendron-street, Helston, Cornwall.*
- 1903 Chapman, Alfred Chaston, F.R.S., F.I.C., F.C.S.
8, *Duke-street,*
London, E.C. 3.
- 1892 Chapman, Frederick, A.L.S., *Palæontologist to the National Museum, Melbourne; Hon. Palæontologist, Geological Survey, Victoria; Past-President, Microscopical Society, Victoria; Lecturer and Demonstrator in Palæontology, Melbourne University.*
Croham Hurst, Threadneedle-street, Balwyn, near Melbourne, Victoria, Australia.
- 1921 Charles, John H. V.
Biochemical Department, Nobel's Explosives Co., Ltd., Ardeer Factory, Stevenston, Ayrshire, N.B.
- 1922 Charles, William Frederick.
The Nook, Loughborough.
- 1925 Chatterton, Frederick J. S.
34, *Elm Park-road, Finchley, N. 3.*
- 1909 Cheavin, Captain W. H. S., F.C.S., F.E.S.
Middlesex Medical College, Berners-street, W. 1.
- 1904 Cheshire, Professor Frederic John, C.B.E., F.Inst.P.
23, *Carson-road, West Dulwich,*
London, S.E. 21.
- 1926 Choat, Ernest Bridgstock, F.Z.S.
Sandon, Bexley-road, Erith, Kent.
- 1885 Clark, Joseph.
Hind Hayes, Street, S.O., Somerset.
- 1925 Clarke, Noel John.
14, *Hills-place, Oxford Circus, W. 1.*
- 1925 Clarkson, G. D., F.C.S.
St. Paul's-road, Mirfield.
- 1924 Clay, Reginald S., B.A., D.Sc., F.Inst.P., F.Op.S.
Eshdale, Fortis Green, London, N. 2.

Service on
Council, etc.Pres. 1924-25;
V.-P. 1926-271908; 1911-15; 1919;
V.-P. 1909-10;
1920-21; 1924-25;
Pres. 1922-23

1926-27. V.-P. 1928-

Elected.		Service on Council, etc.
1924	Clinton, Herbert F. <i>Dept. of Agriculture, 605, Flinders-street, Melbourne, C.3, Victoria, Australia.</i>	
1907	Clowes, William Archibald, F.Z.S. <i>Duke-street, Stamford-street, S.E. 1.</i>	
1924	Coales, John Dennis, D.Sc., M.I.E.E. <i>The Garth, Chislehurst, Kent.</i>	1928-
1926	Cockrill, James S. <i>Gorleston House, Kinross.</i>	
1924	Cocksedge, Herbert Edwin, M.A., B.Sc. <i>Millford, Hartford, Cheshire.</i>	
1925	Codd, Laurence William, M.A. <i>7A, Colville Houses, W. 11.</i>	
1920	Collins, William G. <i>The Cambridge & Paul Instrument Co., Ltd., Chesterton- road, Cambridge.</i>	
1908	Connell, John Gibson. <i>Zoology and Botany Department, Glasgow Provincial Training College, Jordanhill, Glasgow, and 129, Broomhill-drive, Glasgow, W. 1.</i>	
1922	Cook, Hubert T. A. <i>c/o C. T. K. Roberts, Esq., 10, Bedford-circus, Exeter.</i>	V.-P. 1927.
1920	Cooke, William Edmund, M.D., F.R.C.P., D.P.H. <i>Aragon, Swinley-road, Wigan, Lancs.</i>	
1927	Coultas, Joseph Arthur. <i>7, Derby-street, Idle, near Bradford.</i>	
1922	Cox, Miss Rose Ellen Salt. <i>The Bungalow, Monton, Eccles, Manchester.</i>	
1921	Crawley, Walter C., B.A., F.E.S. <i>29, Holland Park-road, W. 14.</i>	
1884	*Crisp, Lady Catherine. <i>5, Lansdowne-road, Notting-hill, W.</i>	
1922	Crow, William Bernard, D.Sc., Ph.D., F.L.S. <i>Dept. of Biology, The Technical College, Huddersfield.</i>	
1891	Crowther, Henry. <i>Curator, Leeds City Museum, Park-row, Leeds.</i>	
1924	Crundall, Sydney F. W., A.C.G.F.C., A.I.C. <i>18, Bold-street, Warrington.</i>	
1922	Cunningham, William T. P. <i>Wilmington, Massetts-road, Horley.</i>	
1919	Curties, Charles Lees. <i>244, High Holborn, W.C. 1.</i>	
1913	Cuzner, Edgar. <i>13, Abbotsford-road, Goodmayes, Essex.</i>	

Elected.

- 1923 Davidson, Frederick N.
143, *Great Portland-street, W. 1.*
- 1916 Davies, Alfred T.
Avon-house, Keynsham, near Bristol.
- 1908 Davies, Daniel.
70, *Le Cren-street, Timaru, New Zealand.*
- 1928 Davis, Osborne.
17, *Windsor-place, Cardiff.*
- 1924 Day, Lionel Edward Hedley.
119, *Oakleigh Park-drive, Leigh-on-Sea.*
- 1924 Dean, Ernest Samuel.
Flat C, 1, Camden-square, N.W. 1.
- 1924 *Delafield, Maturin L.
29, *Avenue Davel, Lausanne, Switzerland.*
- 1926 Delisle, William Harry.
Basseterre, St. Kitts, British West Indies.
- 1927 Denham, R. H. G. Hector.
Rilshaw-lane, Winsford, Cheshire.
- 1915 Denne, Mark Thomas, O.B.E.
310, *Regent-street,*
London, W. 1.
- 1922 Denning, Samuel Thomas.
47, *Derby-road, Croydon.*
- 1921 Depew, Ganson.
Marine Trust Co. Building, Buffalo, N.Y., U.S.A.
- 1920 Derry, D. C. L.
75, *Clifton Court, Maida Vale, N.W. 8.*
- 1928 Desai, Magan.
204, *Hornby-road, Bombay, India.*
- 1885 De Witt, William G.
88, *Nassau-street, New York. U.S.A.*
- 1924 Dibdin, Reginald Aglio.
31, *Idmiston-road, West Norwood, S.E. 27.*
- 1918 Digby, Miss Lettice.
The Kiln, Laver-de-la-Haye,
Colchester.
- 1886 Disney, Alfred Norman, M.A., B.Sc.
14, *Wilton-crescent,*
Wimbledon, S.W. 19.
- 1918 *Dixon, Miss Annie, M.Sc., F.L.S.
Rothamsted Experimental Station, Harpenden.
- 1892 Dixon-Nuttall, Frederick Richard.
Ingleholme, Ecclestone-park, near Prescott,
Lancashire.
- 1919 Dovey, Ernest Roadley, A.R.C.S.
Government Laboratory, Hongkong, China.
- 1907 Dowdy, Sidney Ernest, M.P.S.
Harewood, Marine-parade, Dovercourt, Essex.

Service on
Council, etc.1922-24; 1927-;
V.-P. 1925-281901-05; 1908-09;
1912-14; 1916-18;
V.-P. 1906-07;
1910-11; 1919-20

- | Elected. | | Service on
Council, etc. |
|----------|--|---|
| 1919 | Drescher, Theodore Bausch.
149, <i>Westminster-road, Rochester, N.Y., U.S.A.</i> | |
| 1919 | Drew, Aubrey H., D.Sc.
<i>Imperial Cancer Research Fund, Stroud Laboratories,
The Ridgeway, Mill Hill, N.W. 7.</i> | 1921-22 |
| 1926 | Duffy, Rev. Joseph Gibbins.
<i>Meersbrook, Meikleriggs, Paisley.</i> | |
| 1910 | Duma, Frank Campbell.
102, <i>Commissioner-street, Johannesburg, Transvaal,
South Africa.</i> | |
| 1894 | Duncan, Cecil Cooke, F.I.C., F.C.S.
<i>The County Chemical Laboratory, Shire Hall, Worcester.</i> | |
| 1911 | Duncan, Francis Martin, F.R.P.S., F.Z.S.
19, <i>Staverton-road, Brondesbury Park,
London, N.W. 2.</i> | 1917; 1920-23;
V.-P. 1918-19;
Libr. 1920-24 |
| 1921 | Dunkerly, John S., D.Sc., Ph.D.
<i>Zoology Department, The University, Manchester.</i> | |
| 1919 | *Dunn, Gano, A.I.E.E.
<i>J. G. White Engineering Corporation, 43, Exchange-
place, New York, U.S.A., and 20, Washington-square,
New York.</i> | |
| 1919 | Dunn, Reginald.
90, <i>Lorne-road, Clarendon Park, Leicester.</i> | |
| 1926 | Dunne, Walter John.
<i>Myoora, Irving-road, Toorak, Melbourne, Australia.</i> | |
| 1922 | Du Porte, E. Melville, <i>Lecturer in Zoology and Entomology.
Macdonald College, Quebec, Canada.</i> | |
| 1910 | Earland, Arthur.
<i>Tramore, 113, Holmesdale-road, Reigate, Surrey.</i> | 1912-15; 1920-21;
V.-P. 1916-18; 1922 |
| 1922 | Edwards, Norman Oliver, A.B.S.A.
<i>Bank View, May-street, Durham.</i> | |
| 1899 | Elliott, Oliver Thomas, M.P.S., Ph.C.
<i>c/o Messrs. Philip Harris & Co., Edmund-street,
Birmingham, and The Rowans, Lloyd's-street, Small
Heath.</i> | |
| 1922 | Ellis, Edward Henry.
87, <i>Wolffington-road, West Norwood, S.E. 27.</i> | 1925- |
| 1925 | Ellis, Holmes.
23, <i>Townley-street, Colne, Lancs.</i> | |
| 1928 | Else, Walter Martyn.
10, <i>Eagle Parade, Buxton, Derbyshire.</i> | |
| 1922 | Elton-Bott, John R.
<i>Shwegyin Rubber Estate, Sunthaik, Lower Burma.</i> | |
| 1886 | Ewell, Marshall D., M.D.
749, <i>Tate-avenue, Memphis, Tenn., U.S.A. (May 1 to
Nov. 1), and Gulf View, Treasure Island, Osprey,
Fla., U.S.A. (Nov. 1 to May 1).</i> | Hon. Fellow 1925- |

- Elected.
- 1897 Eyre, John William Henry, M.D., M.S.Durh., D.P.H.,
F.R.S.E., *Professor of Bacteriology in the London University.*
Bacteriological Laboratories, Guy's Hospital, S.E. 1,
62, Wimpole-street, W. 1, and The Warren, Tulse-hill,
S.W. 2.
- Service on
Council, etc.
1904-08; 1909;
P. 1907-08; 1910;
1922-23; 1927-;
Sec. 1911-19;
Pres. 1920-21;
Editor 1922-23
- 1921 Falkner, Herbert John.
Gyfu, Barton, St. Mary Church, Torquay.
- 1927 Fallon, Myles Fitzgerald, M.B., Ch.B.
Ossory, St. James Park, Falls-road, Belfast.
- 1883 *Fawcett, John Edward.
Heron Court, Farnham, Knaresborough.
- 1917 Fendick, Ernest A.
Wicklewood, 22, Finedon-road, Wellingborough.
- 1909 Ferguson, Arthur Duncan.
British Guiana Bank, Georgetown, Demerara, British
Guiana, and Royal Bank of Canada, Princes Street,
E.C.
- 1928 Fikry, Mohammad Aziz, B.A., B.Sc.
Dept. of Botany, King's College, Strand, W.C. 2.
- 1925 Findlay, George Marshall, O.B.E., M.D., D.Sc.
Imperial Cancer Research Fund, 8, Queen-square, W.C.1.
- 1919 Fleuret, John B.
47, Walsingham-road, Hove.
- 1921 Flower, John W.
35, Surrey-street, Strand, W.C. 2.
- 1921 Frith, James Stretton, A.I.C., A.M.S.T.
Ascog, Thelwall, Warrington.
- 1927 Funnell, Kenneth James.
Horsted Farm, Chatham.
- 1912 Gadd, Arthur.
115, Atwood-road, Didsbury, near Manchester.
- 1918 Garbutt, Ernest Chalders.
York House, St. Ives, Cornwall.
- 1919 Garnett, John Benbow.
309, Oxford-road, Manchester.
- 1920 Gatenby, James Bronté, B.A., D.Phil. (Oxon), D.Sc. (Lond.).
Professor of Zoology, Trinity College, Dublin.
- 1922 Gater, Bossley Alan Rex, M.A., D.I.C., F.E.S.
Entomologist, Institute for Medical Research, Kuala
Lumpur, Selangor, Federated Malay States.
- 1922 Gates, R. Ruggles, M.A., Ph.D., F.L.S., Secretary,
Professor of Botany in the University of London.
King's College, Strand, W.C. 2.
- 1925 Gay, Alfred D., F.C.S., M.S.C.I.
49, Thornlaw-road, West Norwood, S.E.27.
- 1923-; Editor 1927-
- 1923-27. Sec. 1923-

Elected.		Service on Council, etc.
1921	Ghosh, Ekendranath, M.Sc., M.D., <i>Professor of Biology.</i> <i>Medical College, Calcutta, India.</i>	
1902	Gibson, Joseph. <i>Elmsfield, Psalter-lane, Sheffield.</i>	
1892	Gifford, Colonel James William. <i>Oaklands, Chard, Somerset.</i>	1908
1921	Gillings, Horace Clifford. <i>48, Hertford-street, Cambridge.</i>	
1921	*Gilpin-Brown, Leslie George. <i>Beauworth Manor, near Alresford, Hants.</i>	
1899	Gleadow, Frank. <i>Bakeham House, Englefield Green, Surrey.</i>	
1923	Glover, Arthur Walker. <i>P.O. Box 7347, Johannesburg, S. Africa.</i>	
1912	Glover, Samuel. <i>Olive Mount, St. Ann's, St. Helens, Lancashire.</i>	
1904	Goadby, Sir Kenneth Weldon, K.B.E., M.R.C.S., L.R.C.P. <i>83, Harley-street, W. 1.</i>	
1928	Gomersall, Percy Phipps. <i>"Grosment," Byron Avenue, Lincoln.</i>	
1928	Goosman, Charles. <i>22, West 7th Street, Cincinnati, Ohio, U.S.A.</i>	
1909	Gordon, Fred. William. <i>101, Park-avenue, New York City, U.S.A.</i>	
1922	Gosling, George Walker. <i>Flat 5, Prince Mansions, Middleton Row, Calcutta, India.</i>	
1927	Graham, Charles H. Edger. <i>26, Gordon-avenue, St. Albans, Christchurch, New Zealand.</i>	
1920	Graham, Joseph, B.Sc. <i>Glen Hurst, Corbridge-on-Tyne.</i>	
1926	Grainger-Shackles, Alfred. <i>The Laboratory, Royal Infirmary, Sheffield.</i>	
1919	Grant, Ernest Henry. <i>3 and 4, Great Winchester-street, E.C. 2.</i>	
1923	Gravelle, Philip O. <i>114, Prospect-street, South Orange, New Jersey, U.S.A.</i>	
1904	Griffiths, Waldron. <i>1, Cecily-hill, Cirencester.</i>	
1924	Gurr, George Thomas, F.C.S. <i>136, New King's-road, S.W. 6.</i>	
1912	Gurrin, Gerald Francis. <i>59, Holborn-viaduct, E.C. 1.</i>	
1902	Güssow, Hans Theodore, <i>Dominion Botanist.</i> <i>Central Experimental Farm, Ottawa, Canada.</i>	

Elected

Service on
Council, etc.
1920. V.-P. 1925

- 1919 Hadfield, Sir Robert A., Bart., D.Sc., F.R.S., F.Inst.P.
22, *Carlton House-terrace, London, S.W. 1.*
- 1923 Hagelstein, Robert, *President, New York Microscopical Society.*
165, *Cleveland-avenue, Mineola, New York, U.S.A.*
- 1893 Hägler, Elmer Ellsworth, M.D.
The Hägler Building, 401, East Capitol-avenue, Springfield, Illinois, U.S.A.
- 1912 Hall, Rev. Charles A.
106, *Colney Hatch-lane, Muswell Hill, N. 10.*
- 1920 Hall, T. D. Tuton.
Technical School, Rochdale.
- 1924 Hamilton, Thomas Dalling.
Royal College of Physicians Laboratory, 2, Forrest-road, Edinburgh.
- 1923 Hannam, James William.
8, *Park-terrace, Otley, Yorkshire.*
- 1919 Harper, Capt. Raymond Sydney, M.R.C.S., L.R.C.P., R.A.M.C.
36, *First-avenue, Hove, Sussex.*
- 1905 Harris, Charles Poulett, M.D. (Lond.), M.R.C.S., L.R.C.P.
192, *Lower Addiscombe-road, Croydon, S.E.*
- 1928 Harris, Frederick William.
The Priory, 126, Church-road, Moseley, Birmingham.
- 1920 Harris, William Charles, F.C.S.
Tayside, Mill Park, Hornchurch, Essex.
- 1925 Hartley, Isaac.
16, *Fern Bank, Nelson, Lancs.*
- 1925 Harvey, Leslie A., A.R.C.S., B.Sc., D.I.C.
Zoology Department, The University, Edinburgh.
- 1927 Haslam, James, M.B., Ch.B.
High Bank, Tonge, Bolton.
- 1919 Hawksley, Charles Worthington.
83, *Wigmore-street, W. 1, and 13, Alma-square, St. John's Wood, N.W. 8.*
- 1916 Hazeldine, Frederick James.
Barnfield, South Godstone, Surrey.
- 1909 Heath, Charles Emanuel.
28, *Loughborough-road, Brixton, S.W. 9.*
- 1922 Hecht, Godfrey Emil.
4, *Avenue-road, Regent's Park, N.W. 8.*
- 1927 Heller, Ernest.
89, *Hadlaubstrasse, Zurich, Switzerland.*
- 1917 Hensman, Leonard Newton, Ph.C., M.P.S.
2, *Killarney-road, Wandsworth, S.W. 18.*
- 1889 Hepworth-Collins, Walter, F.G.S., F.C.S.
Junior Constitutional Club, Piccadilly, W.
- 1891 Heron - Allen, Edward, F.R.S., F.L.S., F.G.S., F.Z.S.,
M.R.I.A., etc.
Large Acres, Selsey Bill, Sussex.

1909-10; 1913;
1921-22;
V.-P. 1911-12; 1914;
1918-19;
Pres. 1916-17

- Elected.
- 1910 Hewlett, Richard Tanner, M.D., F.R.C.P., D.P.H.
*Professor of Bacteriology, Bacteriological Laboratory,
 King's College, Strand, W.C., and The Acre, Crawley
 Down, Sussex.*
- 1904 Hill, Cyril Francis, M.Inst.M.M., A.Inst.P., Treasurer.
Moore, Warrington. 1910-12;
Treas. 1913-
- 1881 *Hill, Joseph Alfred, F.L.S.
St. Bees, Northumberland-road, Leamington.
- 1920 Hill, W. Basil, F.C.S.
Eastfield, Stockton-lane, York.
- 1928 Hindle, William.
227, Angers-street, Montreal, Quebec, Canada.
- 1906 Hiscott, Thomas Henry, F.L.S. 1917-21; 1924-25;
*16, Woodville-road, Ealing, W.5, and 5, Stone Buildings,
 Lincoln's Inn, W.C.2* V.P. 1922-23
- 1923 Hobson, A. D., B.A.
Zoology Dept., The University, Edinburgh.
- 1922 Hobson, Herbert, F.C.S.
8, Barnfield-road, Davenport, Stockport.
- 1922 Hodgson, Leonard Stanley.
San Remo, Ecclesall-road South, Ecclesall, Sheffield.
- 1921 Holder, J. T.
114, Pepys-road, S.E.14.
- 1921 Holt, Alfred, F.C.S.
76, Nipper-lane, Whitefield, near Manchester.
- 1925 Holz, Herman Adolphe.
17, Madison-avenue, New York.
- 1920 Hornyold, Professor Alfonso Gandolfi, D.Sc.
Museo Naval, San Sebastian, Spain.
- 1921 Horton, William.
7, Linnet-lane, Liverpool.
- 1918 Hoseason, Captain William Sandford.
*Harbour Master, Evelyn House, Apollo Bunder, Bombay,
 India.*
- 1917 Howard, Henry J., F.L.S.
6, College-road, Norwich.
- 1918 Hughes, Owen Lloyd.
*The Council School, Trefnanney, Meiford, S.O., Mont-
 gomeryshire.*
- 1927 Hugill, William, M.Met.
*Victoria Chambers, Beeley-street, London-road,
 Sheffield.*
- 1922 Hulls, Leonard G., F.C.S., etc.
Rax, Chidham, near Emsworth, Hants.
- 1921 Hunt, Reginald J. H.
Mutylene, Stanmore-road, Harrow Weald.
- 1913 Hurrell, Harry Edward.
25, Regent-street, Great Yarmouth.

ORDINARY FELLOWS.

]

Elected.

Service on
Council, etc.

- 1920 Ireland, William Jabez.
24, *The Ride, Boston-road, Brentford, Middlesex.*
- 1903 Ives, Frederic Eugene, F.R.P.S., *Member of the Franklin Inst., N.Y., Camera Club, and American Microscopical Soc., F.A.A.A.S.*
1753, *N. 15th-street, Philadelphia, Pa., U.S.A.*
- 1922 Jackson, James Joseph.
30, *Windsor-road, Wanstead, E.11.*
- 1923 Jackson, Joseph Taylor, M.Sc.
College House, Bankura, B.N.R., India.
- 1928 Jearey, Bertram Frederick, F.R.A.S.
Villa Carina, Alexander-road, Muizenberg, Cape Town, South Africa.
- 1925 Jefferies, F. C. B.
Brynmelyn, Winscombe, Somerset.
- 1922 Jennison, James.
Edale, Sandy Lodge-road, Moor Park, Rickmansworth.
- 1901 Johnson, Charles Harold, M.D., C.M., F.R.C.S.E.
22, *The Ridge, Canterbury, near Melbourne, Victoria, Australia.*
- 1912 Johnston, Thomas Harvey, M.A., D.Sc., F.Z.S.
Professor of Zoology, The University of Adelaide, South Australia.
- 1918 Jones, Sir Bertram Hyde, K.B.E.
Clovelly, Upper Warlingham, Surrey.
- 1910 Jones, William Llewellyn.
Feremina, St. Martin's, Guernsey, Channel Islands.
- 1923 Judd, Harold Arthur, B.Sc., A.M.I.C.E.
18, *Chapel-lane, Headingley, Leeds.*
- 1910 Keeley, Frank J., B.S., E.M., *Member of the Council, Academy of Natural Sciences, Philadelphia; Vice-Director, Mineralogical Section, Academy of Natural Sciences, Philadelphia.*
Box 25, *Merion Station, Penna, U.S.A.*
- 1925 Kefalas, Andrew, M.A., M.B., Ch.B., F.S.S.
10, *Staplands-road, Broadgreen, Liverpool.*
- 1918 Kidd, Robert Hicks.
Marlborough House, Newbury, Berks.
- 1927 Killick, Charles Rowe, M.B.
Tower Hill, Williton, Somerset.
- 1927 Kirk, Edward, M.D.
c/o Medical Dept., Hong Kong, China.
- 1927 Kirkconnell, Watson, M.A., F.R.G.S.
Wesley College, Winnipeg, Canada.
- 1905 Kitchin, Joseph.
The Mount, 53, Park-hill-road, Croydon.

Elected.

Service on
Council, etc.

- 1897 Klein, Sydney Turner, F.L.S., F.R.A.S., F.E.S.
Lilly's, Chelsfield, Kent.
- 1920 Knight-Hallowes, K. A., M.A. (Cantab.), A.R.S.M. (Lond.),
F.G.S., A.Inst.M.M., F.Inst.P., Mem.R.S.L.
50, *Regent's Park-road, N.W.1.*
- 1920 Lamb, Morris Charles, F.I.C.
176, *Tower Bridge-road, S.E.1.*
- 1918 Lancaster, Henry C.
Calluna, Woking, Surrey.
- 1865 Lankester, Sir Edwin Ray, K.C.B., M.A., LL.D., F.R.S.,
F.L.S., F.Z.S., *Hon. Fellow of Exeter College, Oxford.*
44, *Oakley-street, Chelsea, London, S.W.3.* 1897. Pres. 1909;
Hon. Fellow 1923
- 1923 Larkin, George Frederick, A.M.I.Mech.E.
Essex House, The Fosseway, Farndon, Newark-on-Trent.
- 1887 Latham, Miss Vida Annette, M.D., D.D.S.
1644, *Morse-avenue, Roger's-park, Chicago, Ill., U.S.A.*
- 1919 Lauwers, Walter H. M., F.P.S.L.
77, *Rue Lamoriniere, Antwerp, Belgium.*
- 1928 Laws, Sydney Gibson.
Bacteriological Laboratory, Medical Dept., Uganda, British East Africa.
- 1921 Le Souëf, Leslie Ernest, M.D., B.S.
c/o Major E. A. Le Seriëf, South Perth, West Australia.
- 1927 Lewis, Frederic Henry, I.S.O.
North Bar, Millway, Reigate.
- 1919 Lissimore, Norman.
The Clinical Laboratory, 6, Victoria-avenue, Harrogate.
- 1926 Lohman, Kenneth E.
455, *South Hill-avenue, Pasadena, California,*
- 1925 Lones, John Mason.
The Laurels, Westbourne-crescent, Edgbaston, Birmingham.
- 1927 Long, John A.
Ferncliffe, Menston-in-Wharfedale, Leeds.
- 1922 Lowe, Frederick Charles.
Park-villa, Wharfedale-street, Wednesbury.
- 1921 Ludford, Reginald James, Ph.D., D.Sc., F.R.H.S.
1, *Oakfield-road, Southgate, N.14, and University College, W.C.1.* 1922-24;
V.-P. 1925-26
- 1926 McCartney, James Elvins, M.D., Ch.B., D.Sc.
147, *Burnt Ash Hill, S.E.12.*
- 1924 Macdonald, Dudley Keppel.
54, *Stebondale-street, Cubitt Town, E.14.*
- 1916 *McEwen, Alfred.
Craig Avel, Tarrytown-on-the-Hudson, New York, U.S.A.

- Elected.
- 1894 Macintyre, John, M.B., C.M., F.R.S.E.
179, *Bath-street, Glasgow.*
- 1919 Mackay, Rev. A. F. Gordon, D.Sc.
Hector, New York, U.S.A.
- 1922 Mackay, Arthur.
Allandale, Ballards-lane, N.3.
- 1921 McLatchie, John Drummond Pryde, M.B., C.M.
34, *Welbeck-street, W.1.*
- 1925 MacLeod, Evan Greville.
61A, *Bold-street, Liverpool.*
- 1925 Mansell, John.
110, *Whitehall-gardens, Chingford, Essex.*
- 1911 Mansfield-Aders, Walter, Ph.D.
Zanzibar, East Africa.
- 1921 Manson, John James, L.D.S.
167, *Canning-street, Glasgow, and Bacteriological
Laboratory, Dental Hospital, Glasgow.*
- 1909 Mapp, Charles Richard, B.Sc.
37, *Montpellier-terrace, Cheltenham.*
- 1920 Marchmont, Reginald Henry.
10, *High-road, Wood Green, N.*
- 1904 Mason, Francis Archibald.
29, *Frankland-terrace, Leopold-street, Leeds.*
- 1925 Mason, William Glanvill, F.N.A.O., F.B.P.O., F.I.O.
7A, *Railway-street, Chatham, Kent.*
- 1921 Mathews, Harold J. C., F.C.S.
Bridge End Brewery, *Burnley.*
- 1922 Maxwell, Edward Kelly, B.A.
10, *St. Charles-square, North Kensington, W.10.*
- 1879 *Mercer, A. Clifford, M.D.
324, *Montgomery-street, Syracuse, N.Y., U.S.A.*
- 1899 Merlin, Augustus Alfred Cornwallis Eliot.
3, *Cleveland-gardens, West Ealing, W.13.*
- 1924 Michie, John Livingstone, F.C.S.
8, *Wilton Hill-terrace, Hawick, Scotland.*
- 1921 Mignot, Ernest A.
9, *Cranwick-road, Stamford-hill, N.16.*
- 1924 Millar, William G., M.B., Ch.B.
Pathology Department, University of Edinburgh.
- 1895 Millard, Edgar James, F.C.S.
35-42, *Charlotte-street, E.C.2.*
- 1928 Miller, George Ernest.
63, *Fernlea-road, Mitcham, Surrey.*
- 1891 Miller, John Albert, M.Sc., Ph.D., F.C.S., *Chemist to the State
of New York.*
176, *Norwood-avenue, Buffalo, N.Y., U.S.A.*
- 1912 Mills, Frederick William, F.L.S.
Woodford Hall, Milton Damerel, N. Devon.

Service on
Council, etc.

Elected.

Service on
Council, etc.

- 1925 Mirza, M. B., B.Sc.
*Zoologische Institut, 6, Robert Mayerstrasse, Frankfurt
A/M, Germany.*
- 1905 Moffat, Eliezar.
75, High-street, Chatham.
- 1911 Mond, Robert, Ludwig, M.A., F.R.S.E., F.Inst.P., F.C.S.,
F.Ph.S., F.G.S., F.Z.S.
Combe Bank, Sevenoaks, Kent.
- 1924 Morgan, Richard F., Phar.D., Professor of Botany, School of
Pharmacy, University of Buffalo.
139, W. Oakwood-place, Buffalo, New York, U.S.A.
- 1915 Mosley, Frederick Ormrod.
*University College, Reading, and Whernside, Basing-
stoke-road, Reading.*
- 1925 Mottram, James Cecil.
Radium Institute, Riding House-street, W.1.
- 1900 Murphy, Albert John, F.C.S.
2, Dorset-square, N.W.1, and Sheen-lane, S.W.14.
- 1919 Murray, James Alexander, M.D., F.R.S.,
Director, Imperial Cancer Research Fund.
8, Queen-square, London, W.C.1.
- 1926 Nair, S. R., B.Sc.
35, G.M.C. Residency, Byculla, Bombay, 8.
- 1914 Nall, George Herbert.
Ayot Lodge, Ayot St. Peter, Welwyn, Herts.
- 1926 Needham, George H., M.Sc.
327, East 19th-street, Brooklyn, N.Y., U.S.A.
- 1890 *Nelson, Edward Milles.
34, Apsley-road, Clifton, Bristol.
- 1923 Newton, Charles Arthur.
4, Lansdowne-road, Seven Kings, Essex.
- 1911 Noad, Lewis.
7, King's Bench-walk, Temple, E.C.
- 1924 *Nomani, Mah.
24, Cantonment-road, New Delhi, India.
- 1899 Norman, Albert, L.R.C.P. and L.R.C.S. Edin.
35, Coleherne-road, Earl's Court, S.W.10.
- 1921 Norman, Albert.
New Haw, Weybridge.
- 1925 Nurnberg, Roy Charles Albin.
*c/o Messrs. Andrews & George Inc., Shiba Park, Tokyo,
Japan.*
- 1920 Oakden, Charles H.
30, Meadow-road, Shortlands, Kent.
- 1883 Offord, John Milton.
8, Culmington-road, West Ealing, W.13.

1927-

1920. Sec. 1921-25 ;
Pres. 1926-27 ;
V.-P. 1928-

1892-04 ; 1902 ; 1905 ;
V.-P. 1895-96 ;
1900-01 ; 1908-04 ;
Pres. 1897-99

1915-18.

- | Elected. | | Service on
Council, etc. |
|----------|---|--|
| 1927 | Ogg, Alexander, B.Sc., Ph.D.
<i>Professor of Physics, University of Cape Town, Cape Town, South Africa.</i> | |
| 1907 | Ogilvy, James Wilson.
<i>20, Mortimer-street, W.1.</i> | 1914; 1925-26 |
| 1919 | Oppenheimer, Major Frank, I.M.S., M.B., Ch.B., D.T.M.,
D.T.H., F.R.S.T.M., and H., F.R.I.P.H.
<i>c/o Messrs. Grindlay & Co., Bombay, India.</i> | |
| 1923 | Owen, Charles Todd.
<i>The Logs, East Heath-road, Hampstead, N.W.3.</i> | |
| 1900 | Oxbrow, Alfred William.
<i>7, Old Haymarket, Norwich.</i> | |
| 1926 | Paine, A. Harold.
<i>The Grey House, 48, Broxbourne-road, Orpington, Kent.</i> | |
| 1924 | Palethorpe, Harry Thomas, M.P.S.
<i>3, Imperial-avenue, Narborough-road, Leicester.</i> | |
| 1910 | Palmer, Thomas Chalkley, <i>President of Delaware County
Institute of Science, President of the Academy of Natural
Sciences of Philadelphia.</i>
<i>Media, Delaware Co., Penn., U.S.A.</i> | |
| 1924 | Parish, Charles B.
<i>Quaker Oats Ltd., 11, Finsbury-square, E.C.2.</i> | |
| 1919 | Parish, Rev. Herald.
<i>657, Liverpool-road, Patricroft, Manchester.</i> | |
| 1920 | Parker, James Gordon, Ph.D., F.I.C.
<i>17, Leather Market, S.E.1.</i> | 1923 |
| 1923 | Parkes, Alan Sterling, M.A., Ph.D.
<i>Institute of Physiology, University College, W.C.1.</i> | 1926- |
| 1928 | Parr, Walter James.
<i>17, Bokhara-road, Caulfield, S.E.8, Melbourne,
Australia.</i> | |
| 1924 | Parsons, The Hon. Sir Charles, O.M., K.C.B., M.A., LL.D.,
D.Sc., F.R.S.
<i>1, Upper Brook-street, W.1.</i> | V.-P. 1926-27 |
| 1890 | *Paterson, Mrs. Catherine Childs.
<i>15, Compayne-gardens, N.W.6.</i> | |
| 1907 | Paulson, Robert, F.L.S.
<i>Glenroy, Cecil-park, Pinner, Middlesex.</i> | 1915-17; 1922-24;
V.-P. 1918-19;
Libr. 1925-26 |
| 1898 | Payne, Arthur E. T.
<i>Physiological Laboratory, University of Melbourne,
Victoria, and Scotsburn, Toorak, Melbourne, Victoria.</i> | |
| 1884 | *Peek, The Honourable Lady.
<i>Widworthy Court, Honiton.</i> | |
| 1925 | Pilditch, F. W.
<i>66, Tetley-road, Hall Green, Birmingham.</i> | |
| 1898 | Pillischer, Jacob.
<i>88, New Bond-street, W.1.</i> | |

Elected.		Service on Council, etc.
1911	Pinchin, Ernest Alfred, B.Sc. (Lond.), F.I.C. 136, <i>Sternhold-avenue, Streatham-hill, S.W.2.</i>	1926-27
1924	Piney, Alfred, M.D., Ch.B., M.R.C.P., M.R.C.S. <i>Cancer Hospital, Fulham-road, S.W.</i>	
1907	Pledge, John Harry. 72, <i>Nibthwaite-road, Harrow, Middlesex.</i>	
1926	Pledger, Robert Howland, B.Sc. <i>Ewell Castle, Surrey.</i>	
1919	Poignand, Rev. Cecil W., M.A. <i>The Beccles, Walsham-le-Willows, near Bury St. Edmunds.</i>	
1924	Pollard, Hugh B. C. 22, <i>Loudoun-road, N.W.8.</i>	
1902	Poser, Max. 16, <i>Vick Park B., Rochester, N.Y., U.S.A., and c/o Bausch & Lomb, St. Paul-street, Rochester, N.Y., U.S.A.</i>	1913
1923	Potter, Herbert. 387, <i>Moseley-road, Birmingham.</i>	
1892	Pound, Charles Joseph. <i>Director, Stock Experiment Station, Yeerongpilly, Queensland, Australia.</i>	
1926	Ramanurjam, S. G. Manavala, M.A., Ph.D. <i>Neela Vilas, Poonamali-road, Vepery, Madras, South India.</i>	
1896	Ranken, Charles, F.C.S. 11, <i>Stockton-road, Sunderland.</i>	
1928	Rao, L. Narayana, M.Sc. <i>Assistant Professor of Botany, Central College, Bangalore, South India.</i>	
1921	Rau, A. Subba, D.Sc., B.A. <i>Department of Physiology, University of Mysore, Medical College, Bangalore City, South India.</i>	
1926	Rayner, Alfred George. 25, <i>Couthurst-road, Blackheath, S.E.3.</i>	
1910	Reid, Alfred, M.B., D.P.H., B.Hy. Durh., M.R.C.S. Eng., L.R.C.P., <i>Government Medical Officer.</i> <i>Kuala Lumpur, Selangor, Federated Malay States.</i>	
1920	Reid, Duncan James, M.B., C.M. 20, <i>Blakesley-avenue, Ealing, W.5.</i>	
1899	Rheinberg, Julius. <i>Inglennook, 12, Brondesbury-park, N.W.</i>	
1928	Rhodes, Henry. <i>Melbourne Lea, Whitegate, Halifax, Yorks.</i>	
1927	Rhodes, Herbert William. 7, <i>Ashburn-place, Ilkley, Yorks.</i>	
1924	Rhys-Davies, William. 14, <i>Dock-street, Leeds, Yorks.</i>	

1905-07; 1909-14;
1920-21; 1928-
V.-P. 1915

- | | | |
|----------|--|-----------------------------|
| Elected. | | Service on
Council, etc. |
|----------|--|-----------------------------|
- 1893 Richardson, Frederic William, F.I.C., F.C.S., *County Analyst, Bradford, and Oak Lea, Menston, Yorks.*
- 1916 Richardson, John.
11, *Observatory-road, East Sheen, S.W.14.*
- 1926 Rigby, John Tomlinson.
21, *Hereford-road, Southport.*
- 1928 Roberts, Edward George Treweeke.
Southernhaye, Tavistock-road, Launceston, Cornwall.
- 1921 Roberts, William James David.
31, *Tollington-road, N.7.*
- 1921 Robins, Edmund Arthur. 1926-
Gorran, Cassiobury-park-avenue, Watford, Herts.
- 1910 *Robins, Herbert George, F.R.G.S.
Toms Farms, Wankie, S. Rhodesia, South Africa.
- 1924 Robinson, Lieut-Colonel A. C.
5, *Emperor's Gate, S.W.7.*
- 1917 *Robinson, Miss Nancy M.
Glassel House, Glassel, Aberdeenshire.
- 1927 Robinson, Sydney Harold.
The Homestead, York-avenue, Lincoln.
- 1899 Rogers, George Henry James.
Wilton Hotel, Grosvenor-gardens, St. Leonards-on-Sea.
- 1924 Rogers, T. Howard.
16, *Great Western Arcade, Birmingham.*
- 1921 Room, H. W. Reginald.
Sunnymead, Lansdown-road, Bromley, Kent.
- 1924 Rosenberg, Augustus.
Tollard Royal, Bournemouth.
- 1911 Ross, John Pilkethly, M.P.S.
P.O. Box 228, Bombay.
- 1904 Ross-Mackenzie, John, F.C.S.
Woodleigh, Selborne-road, Barbourne, Worcester.
- 1918 Rowley, Frank, M.I.M.M.
159, *Adelaide-road, N.W.3.*
- 1897 Rowley, Frederick Richard.
*Curator, Royal Albert Memorial Museum, Exeter, and
4, Victoria Park-road, Exeter.*
- 1922 Rudd, Frank E., L.D.S., R.C.S. (Eng.).
43, *Prince of Wales-road, Norwich.*
- 1917 Ryland, Lieut.-Colonel Alfred W.
30, *Higher Bank-road, Fulwood, Preston.*
- 1922 Saguchi, Professor Sakae.
Kanazawa Medical College, Kanazawa, Japan.
- 1918 Salmon, Walter.
*Sandinway, 66, Goldieslie-road, Wyld Green, Bir-
mingham.*

Elected.

Service on
Council, etc.

- 1892 *Salomons, Sir David Lionel, Bart., J.P., M.A., D.L., F.R.G.S.,
F.G.S., F.Z.S.
Broomhill, Tunbridge Wells.
- 1923 Sansom, George Samuel, D.Sc.
Kennel Moor, Milford, Surrey.
- 1909 Saxton, Thomas R., Assoc.M.Inst.C.E.
43, East Bank, Stamford Hill, N.16.
- 1928 Sayceduddin, M., B.Sc.
Yakootpura, Hyderabad, Deccan, India.
- 1925 Schmehlik, R.
Berlin-Dahlem, M. Schwarzen Grund 25.
- 1925 Schoonhoven, John J., M.A.
773, Eastern Parkway, Brooklyn, N.Y., U.S.A.
- 1880 Scott, Dukinfield Henry, M.A., D.Sc., Ph.D., LL.D., F.R.S.,
F.L.S. Pres. 1904-06;
V.-P. 1907
*East Oakley House, Basingstoke, Hants, and Athenæum
Club.*
- 1916 Scott, Joseph Henry.
Oakfield, 8, Chambers-road, Southport.
- 1913 Scott, Wm., F.R.C.V.S.
Frian House, Bridgwater.
- 1900 *Scourfield, David J., I.S.O., F.Z.S. 1908-13; 1924-25;
V.-P. 1914-15;
1921-22;
Sec. 1916-20
63, Queen's-road, Leytonstone, E. 11.
- 1907 Scriven, Charles R.
32, Old Queen-street, Westminster, S.W. 1.
- 1917 Sears, R. S. W.
1, Lisson-grove, Marylebone, N.W. 1.
- 1924 Setna, Sam B., B.Sc., M.Sc.
Station-terrace, Grant-road, Bombay, India.
- 1928 Shackle, John Walker, M.R.C.S., L.R.C.P.
Guy's Hospital, S.E. 1.
- 1923 Sharif, Mohd., M.Sc.
*Entomological Section, Zoological Survey of India,
Indian Museum, Calcutta, India.*
- 1902 Sharpe, Charles James.
130, Fenchurch-street, E.C. 3.
- 1926 Sheard, Hubert V.
"Hollin Deane," Rigton-lane, Bardsey, near Leeds.
- 1885 *Shelley, Major A. D. G., R.E. (retired).
Hitherbury, Portsmouth-road, Guildford.
- 1910 Sheppard, Alfred William, F.L.S. 1914-15; 1917-19
c/o Longmans, Green & Co., 39, Paternoster-row, E.C. 4.
- 1909 Sheppard, Edward James. 1916-22; 1923-;
Cur. Slides 1914-;
V.-P. 1923-24
137, Kennington-road, Lambeth, London, S.E. 11.
- 1924 Shorter, Henry C.
39, Villiers-road, Southall.
- 1922 Shroff, Peshotan D., B.Sc., Assistant Professor of Biology, c/o
The Principal, St. Xavier's College, Fort, Bombay, India.

Elected.

Service on
Council, etc.

- 1909 Sidwell, Clarence J. H.
46, *Ashbourne-grove, East Dulwich, S.E.*
- 1921 Sierra, J. M.
*Biological Laboratory, Cadby Hall, Kensington, W. 14,
and 7, Oakley-avenue, W. 5.*
- 1912 Simpson, Norman Douglas, B.A., F.L.S.
*c/o The Ministry of Agriculture, Cotton Research Board,
Giza, Egypt.*
- 1925 Singh, Bawa Balwant, M.Sc.
Government College, Rohtak, Punjab, India.
- 1924 Smiles, John, A.R.C.S.
22, *Coniston-road, Muswell Hill, N. 10.*
- 1925 Smith, Charles A.
19, *Miranda-road, Highgate, N. 19.*
- 1917 Smith, Joseph, F.S.A.A.
Kenwyn, 90, Kenwyn-road, Ellacombe-road, Torquay.
- 1897 Soar, Charles David, F.L.S.
96, *Madrid-road, Barnes, S.W. 13.*
- 1918 Springall, Hubert F.
The Friars, King's Lynn.
- 1925 Stansfield, Victor.
*Laues Agricultural Trust, Rothamsted Experimental
Station, Harpenden, Herts.*
- 1909 Stewart, Thomas S., M.D.
1532, *Pine-street, Philadelphia, Pa., U.S.A.*
- 1900 Stiles, Matthew Henry.
10, *Avenue-road, Doncaster.*
- 1921 Stobart, Captain Henry Francis.
- 1914 Strachan, James, F.Inst.P.
*Devonshire House, 18, Pelham-road, Gravesend,
Kent.*
- 1923 Stream, Ernest John, M.A. (Cantab.).
Glenville, Heneage-road, Grimsby.
- 1871 Stuart, John.
3, *North Side, Clapham Common, S.W. 4.*
- 1921 Stump, Dan M., B.S., M.E.
546, *N. Cuyler-avenue, Oak Park, Ill., U.S.A.*
- 1918 Sutcliffe, Herbert.
163A, *Ampung-road, Kuala Lumpur, Federated Malay
States.*
- 1920 Sutherland, Donald, M.A., F.R.S.G.S.
*Golden Hurst, 20, Carmunnock-road, Cathcart,
Glasgow.*
- 1906 Swift, Mansell James.
81, *Tottenham Court-road, W. 1.*
- 1889 Sykes, Mark Langdale.
Lawton House, The Strand, Ryde, Isle of Wight.

1915-19

Elected.

Service on
Council, etc.

- 1891 *Talmage, James Edward, D.Sc., Ph.D., F.R.S.E., F.G.S.,
*Professor of Geology, University of Utah, Salt Lake City,
Utah, U.S.A.*

47, *East South Temple-street, Salt Lake City, Utah.*

- 1925 Talmage, Sterling Booth, M.Sc.
*Dept. of Zoology, Northwestern University, Evanston,
Ill., U.S.A.*

- 1900 Taverner, Henry.
*Wrekin House, 319, Seven Sisters-road, Finsbury
Park, N.4.*

- 1891 Terry, Edwin, F.C.S.
7, *Mostyn-road, S.W. 9.*

- 1921 Thapar, Gobind Singh, M.Sc., Ph.D., *Professor of Zoology.
Department of Zoology, The University, Lucknow, India.*

- 1923 Thomas, Evan John, M.P.S.
229, *Park-road, Cwm Park, Treorchy, Glam.*

- 1885 *Thomson, J. Arthur, M.A., LL.D., F.R.S.E., F.Z.S., *Regius
Professor of Natural History in the University of Aberdeen.
Natural History Department, Marischal College, Uni-
versity, Aberdeen, and Castleton House, Old Aberdeen.*

Pres. 1910-11

- 1912 Tierney, Clarence, D.Sc., F.L.S., *Secretary.
Coulsdon, Surrey, and Athenæum Club, S.W.1.*

1921-22; 1925;
V.-P. 1923-24;
Sec. 1926-

- 1923 Tipnis, Eknath Ganesh, B.A.
P.O. Avas, Dist. Kolabra, via Bombay, India.

- 1923 Titchener, George R.
10, *Dalberg-road, Brixton, S.W. 2.*

- 1926 Titchener, J. B.
Hatherwood, Manor Way, Beckenham, Kent.

- 1925 Toorkey, Dinshaw Rustumji, B.Sc.
c/o Thomas Cook & Son, 54, Princess-street, Edinburgh.

- 1926 Townley, Miss Muriel.
9, *Wexford-road, Oxtou, Birkenhead.*

- 1925 Troughton, Henry George.
5, *Stone Buildings, Lincoln's Inn, W.C.2.*

- 1920 Turner, William.
21, *Vera-road, Fulham, S.W.*

- 1913 Verrall, Frederick, H., B.A., LL.B.
The Hollies, Worthing, Sussex.

- 1926 Vickers, A. Eric J., M.Sc., A.I.C., F.C.S.
27, *Lily-street, Wolstanton, Stoke-on-Trent.*

- 1928 Wagstaffe, Reginald.
102, *Cambridge-road, Southport, Lancs.*

- 1923 Wallis, Thomas Edward, B.Sc., F.I.C., Ph.C.
21, *Sunbury-avenue, Mill Hill, N.W.7.*

- 1909 Walter, Rev. Frederick William.
The Manse, Kelvedon, Essex.

Elected.

Service on
Council, etc.

- 1923 Warbrick, John Clark, M.D.
306, *East 43rd-street, Chicago, Ill., U.S.A.*
- 1920 Ware, John William.
P.O. Box 1404, Durban, Natal, South Africa.
- 1885 Warner, Edmond.
5, *York Gate, Regent's Park, N.W.1.*
- 1919 Watkinson, Harry.
Westwoods, Welholme-road, Grimsby.
- 1912 Webb, Wilfred Mark, F.L.S.
The Hermitage, Hamwell, W.
- 1927 Welch, Archibald Parker.
Crockley House, 213, Brentford-road, Romford, Essex.
- 1924 Welch, Frank Victor.
152, *Broadway, West Hendon, N.W.9.*
- 1920 Welsford, Miss Evelyn Janie, M.B.E., F.L.S.
The Laboratory, Dell Park, Englefield Green, Surrey.
- 1920 Westerdijk, Tiddie.
Keizersgracht, 642-44, Amsterdam, Holland.
- 1928 Wetzel, Reinhard A., B.S.
Supervisor of Physics, Townsend Harris Hall, College of the City of New York, N.Y., U.S.A.
- 1919 Whipp, James Ewart, M.P.S.
15, *St. John-street, Longsight, Manchester.*
- 1886 *Whitehead, Ralph Radcliffe.
Woodstock, Ulster C., N.Y., U.S.A.
- 1920 Whitfield, Herbert Charles.
6, *Kassala-road, Battersea Park, S.W.11.*
- 1898 *Whittaker, Oscar, F.E.S.
Box 248, Hollyburn, British Columbia.
- 1915 Whitteron, Frederick, B.A.
317, *City-road, South Melbourne, Victoria, Australia.*
- 1910 *Wilding, Percy P.
Fern Nook, Penwortham Hill, Preston, Lancs.
- 1921 Wildman, J. T. R.
36, *Etherley-road, South Tottenham, N.15.*
- 1922 Wilkie, Henry Charles, F.R.C.V.S., Hon. F.Z.S.
c/o Messrs. Coutts and Co., 440, Strand, W.C.2, and Dunbar Villa, Redinnick, Penzance.
- 1922 Williamson, William, F.R.S.E., F.L.S.
7, *Ventnor-terrace, Edinburgh.*
- 1925 Wills, H. Haydyn, F.C.S.
17, *Green-lane, Redruth.*
- 1908 Wilson, Joseph.
The Hawthorns, 3, West Park-road, Kew Gardens.
- 1911 Wilton, Edmund Wade, A.I.S.E., F.S.A.
Planet Works, Bramley, Leeds, and Swinnow House, Pudsey, Yorks.

Elected.		Service on Council, etc.
1925	Winter, Frank. 2, <i>Duke-street, S.W.</i>	
1928	Wood, John Walker, L.R.C.P., L.R.C.S. Edin. <i>Belvedere-terrace, 19, Church-road, Tunbridge Wells.</i>	
1923	Woodger, Arthur George. 8, <i>Manor-avenue, Bath-road, Hounslow.</i>	
1880	*Woodward, Bernard B., F.L.S., F.G.S. 4, <i>Longfield-road, Ealing, W.5.</i>	1918-19
1889	Wright, Charles Henry. 10, <i>Clarence-road, Kew.</i>	
1925	Wright, Rev. Frederick James, M.B.A.A. 332, <i>Audley Range, Blackburn, Lancs.</i>	
1925	Wright, H. Cameron. 3, <i>Stanhope-road, Highgate, N.6.</i>	
1882	Wright, Prof. R. Ramsay, M.A., B.Sc. 9, <i>Moreton-road, Oxford.</i>	
1921	Wrighton, Harold, B.Met. 64, <i>Kinveachy-gardens, Charlton, S.E.7.</i>	1924-26
1900	Wyatt, William. <i>Rutland House, Ellesmere Park, Eccles, Manchester.</i>	
1919	Wycherley, Sydney R. <i>Netherleigh, Keswick-road, Orpington, Kent.</i>	
1928	Yarwood, Albert Reginald. 18, <i>Lesley-road, Southport.</i>	
1890	*Youdale, William Henry.	
1918	Young, George William. 20, <i>Grange-road, Barnes, S.W.</i>	
1920	Zwick, Karl George, Ph.C., Ph.D., M.D. <i>Doctors' Building, Garfield-place, Cincinnati, U.S.A., and 3444, Cornell Place, Clifton, Cincinnati, Ohio, U.S.A.</i>	

HONORARY FELLOWS.

Elected.

1879 Balbiani, E. G.

Paris.

1918 Bruce, Lady Mary Elizabeth, R.R.C.

London.

1925 Ewell, Marshall D., M.D.

Memphis and Treasure Island, U.S.A.

1905 Jennings, H. S.

Baltimore.

1928 Lankester, Sir Edwin Ray, K.C.B., M.A., LL.D., F.R.S., F.L.S., F.Z.S.

London.

1912 Penard, Dr. Eugene.

2, Rue Töpffer, Geneva.

1904 Ramón y Cajal, S.

Madrid.

1923 Rendle, Alfred Barton, M.A., D.Sc., F.R.S., F.L.S., etc.

British Museum (Natural History), London, S.W. 7.

1879 Sars, G. O.

Christiania.

1904 Teall, J. J. H.

London.

1879 Warming, E.

Copenhagen.

1905 Wilson, E. B.

New York.

1905 Wood, R. W.

Baltimore.

Past-Presidents.

	Elected.
*SIR RICHARD OWEN, K.C.B., D.C.L., M.D., LL.D., F.R.S.	1840-1
*JOHN LINDLEY, Ph.D., F.R.S.	1842-3
*THOMAS BELL, F.R.S... ..	1844-5
*JAMES SCOTT BOWERBANK, LL.D., F.R.S... ..	1846-7
*GEORGE BUSK, F.R.S.	1848-9
*ARTHUR FARRE, M.D., F.R.S.	1850-1
*GEORGE JACKSON, M.R.C.S.	1852-3
*WILLIAM BENJAMIN CARPENTER, C.B., M.D., LL.D., F.R.S.	1854-5
*GEORGE SHADBOLT	1856-7
*EDWIN LANKESTER, M.D., LL.D., F.R.S.	1858-9
*JOHN THOMAS QUEKETT, F.R.S.	1860
*ROBERT JAMES FARRANTS, F.R.C.S.	1861-2
*CHARLES BROOKE, M.A., F.R.S.	1863-4
*JAMES GLAISHER, F.R.S.	1865-6-7-8
*REV. JOSEPH BANCROFT READE, M.A., F.R.S.	1869-70
*WILLIAM KITCHEN PARKER, F.R.S.	1871-2
*CHARLES BROOKE, M.A., F.R.S.	1873-4
*HENRY CLIFTON SORBY, LL.D., F.R.S.	1875-6-7
*HENRY JAMES SLACK, F.G.S.	1878
*LIONEL S. BEALE, M.B., F.R.C.P., F.R.S... ..	1879-80
*PETER MARTIN DUNCAN, M.B., F.R.S.	1881-2-3
*REV. WILLIAM HENRY DALLINGER, M.A., LL.D., F.R.S.	1884-5-6-7
*CHARLES THOMAS HUDSON, M.A., LL.D. (Cantab.), F.R.S.	1888-9-90
*ROBERT BRAITHWAITE, M.D., M.R.C.S.	1891-2
*ALBERT D. MICHAEL, F.L.S... ..	1893-4-5-6
EDWARD MILLES NELSON	1897-8-9
*WILLIAM CARRUTHERS, F.R.S., F.L.S., F.G.S.	1900-1
*HENRY WOODWARD, LL.D., F.R.S., F.G.S., F.Z.S.	1902-3
DUKINFIELD HENRY SCOTT, M.A., Ph.D., LL.D., F.R.S., F.L.S.	1904-5-6
*THE RIGHT HON. LORD AVEBURY, P.C., D.C.L., LL.D., F.R.S., etc.	1907-8
SIR EDWIN RAY LANKESTER, K.C.B., M.A., LL.D., F.R.S., F.L.S., F.Z.S.	1909
J. ARTHUR THOMSON, M.A., F.R.S.E.	1910-11
*HENRY GEO. PLIMMER, F.R.S., F.L.S., F.Z.S., etc.	1911-12
*SIR GERMAN SIMS WOODHEAD, M.A., M.D., LL.D., F.R.S.E., etc.	1913-15
EDWARD HERON-ALLEN, F.R.S., F.L.S., F.G.S., etc.	1916-17
JOSEPH E. BARNARD, F.R.S., F.Inst.P.	1918-19
JOHN H. EYRE, M.D., M.S., F.R.S.Edin.	1920-21
FREDERIC J. CHESHIRE, C.B.E., F.Inst.P.	1922-23
A. CHASTON CHAPMAN, F.R.S., F.I.C., F.C.S.	1924-25
JAMES A. MURRAY, M.D., B.Sc., F.R.S.	1926-27

* Deceased.

Royal Microscopical Society

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